CEMENTS, DRILL CUTTINGS, AND MUDS DISCHARGE MODELING

FOR

BURGER J WELL, LOCATED OFFSHORE CHUKCHI SEA, ALASKA

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EXECUTIVE SUMMARY

The primary goal of this environmental numeric modeling was to simulate the dispersion and deposition of the cement, water based drill cuttings, and drilling fluids discharges from the prospect well **Burger J** located offshore Chukchi Sea using the Offshore Operators Committee Mud and Produced Water Discharge Model (**OOC Model**). The prospect well Burger J is located in Block 6912 of area Posey. The depth of water is 43.9 meters (m). The dispersion and deposition numeric simulations were performed for the six discrete drilling intervals divided into two discharge scenarios: sea floor (013) and sea surface (001). The sea floor discharges occur from the drilling intervals 1, 2, and 3 and the sea surface discharges occur from the drilling intervals 4, 5, and 6. The sea floor discharges occur at 1.83 m (or 6 feet) above the sea floor and the sea surface discharges occur at 6.7 m below the sea surface.

A pump will be used at the sea floor during the drilling of the top hole section i.e., the drilling intervals 1, 2, and 3 for the sea floor (013) discharges. A flexible hose suction pipe will suck a large volume of sea water to move the cement, water based drill cuttings, and drilling fluids from the seafloor and will discharge from a 16.0 inch internal diameter discharge pipe at 18,000 gallons per minute (gpm). This yields into 118, 135, and 186 pre-dilution factors before discharging into the ambient for the drilling intervals 1, 2, and 3, respectively. The discharge pipe of the seafloor pump is located at 1.83 m (or 6.0 feet) above the seafloor and oriented horizontally aligned with the direction of the current, which is to the East. The sea floor pump's discharge rate of **18,000 gpm** is equivalent to **25,714.29** barrels per hour (bbls/hour).

Sea water at a rate of 10 barrels per minute (bbls/min) will be added to the drill cuttings and drilling fluids before discharging into the ambient during the drilling of the bottom hole section i.e., the drilling intervals 4, 5, and 6 for the sea surface (001) discharge scenario.

The pre-diluted effluent discharge rates during the drilling intervals 1, 2, 3, 4, 5, and 6 are: 25714.29, 25714.29, 25714.29, 696.68, 700.54, and 619.89 bbls/hour, respectively. Cement is being discharged only for the sea floor discharge scenario and is included in the volume of drill cuttings. Approximately 1,500 bbls of drilling fluids will be discharged at the end of the drilling of the well from the rig's surface pits.

The solids deposition on the seabed from the effluents discharged during the six discrete drilling intervals and the rig's surface pits were compiled using the Graphical User Interface Discharge Offshore (GUIDO, version 7.0) software for the OOC model yielding the total solids deposition loading and total thickness distribution on the seabed from the drilling operation at the Burger J well site.

The OOC model predicted total amount of solids loading on the sea floor as a result of the discharge of cement, water based drill cuttings, and drilling fluids are: (i) less than 1 kg/m^2 at a distance 350 m from the source, (ii) less than 0.1 kg/m^2 at 1.1 km from the source, and (iii) less than 0.01 kg/m^2 beyond 2.7 km from the source.

The sea floor areas affected by solids deposit loading of more than 1000-, 100-, 10-, 1-, 0.1-, 0.01- and 0.001-kg/m^2 are: 0.108, 0.264, 0.594, 3.663, 18.610, 130.974, and 729.182 hectares(ha), respectively.

The OOC model predicted maximum deposit thickness of 207 cm occurs at 2.0 m north from the discharge location. It decreases to a value of 1 cm at a distance approximately 100 m to the east from the discharge location.

The sea floor area affected by solids deposit thickness of 1 cm or larger is approximately a 120 m x 40 m rectangle area (or 0.512 ha to be exact). The sea floor areas affected by deposit thickness larger than 200-, 100-, 10-, and 1-cm are: 0.081, 0.102, 0.196, and 0.512 ha, respectively.

The total suspended solids (TSS) concentrations during the drilling operations are: 7 to 82 mg/l at 100 m; 2 to 19 mg/l at 300 m; and 0 to 3 mg/l at 1 km distances from the source. The maximum TSS concentrations occur during the discharge of drilling fluids from the Rig's surface pits for duration of 1.5 hours only. They are: 241 mg/l at 100 m, 104 mg/l at 300 m, and 0 mg/l at 1 km distances from the source.

The impacts on the ambient from the drilling operations at the Burger J well in terms of solids deposit thickness of 1 cm or larger is limited to an area of less than 1 ha. The impacts at 100 m from the discharge source are: solids deposit thickness of 1 cm on the seabed and TSS concentrations in the range of 7 to 82 mg/l. The impacts beyond 300 m from the source are low: solids deposit thickness of less than 1 cm on the seabed and TSS concentrations of 2 to 19 mg/l. The overall impacts on the ambient from the drilling operations at the Burger J well can be classified as low.

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SECTION 1.0 INTRODUCTION

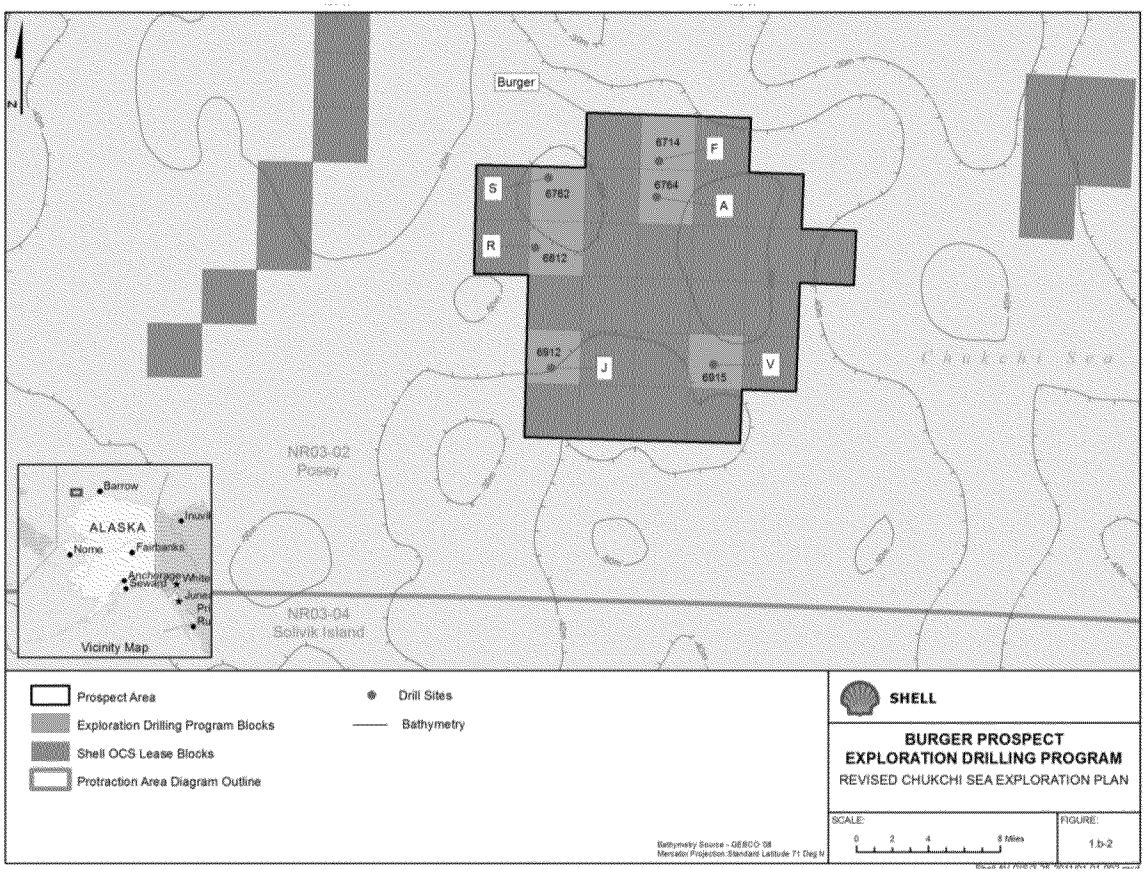
The numeric simulations for the cement, water based drill cuttings, and drilling fluids discharges from the prospect well **Burger J** located offshore Chukchi Sea was conducted using the Offshore Operators Committee Mud and Produced Water Discharge Model (**OOC Model**). The location of the well Burger J, within the Burger Field offshore the Chukchi Sea is presented in **Figure 1-1**. It's located in Block 6912 of area Posey. The coordinates: easting-northing and latitude-longitude are presented in **Table 1-1**. The depth of water is 43.9 meters (m). The dispersion and deposition numeric simulations were performed for two discharge scenarios listed below:

- **Discharge Scenario 1**: **Sea Floor Discharges (013)**
  Cement, drill cuttings, and drilling fluids discharges prior to the installation of the riser near the sea floor.

- **Discharge Scenario 2: Sea Surface Discharges (001)**
  Drill cuttings and drilling fluids discharges after the installation of the riser near the sea surface.

  Approximately 1,500 bbls of drilling fluids will be discharged at the end of the drilling of the well from the rig's surface pits at a rate of 1,000 barrels (bbls) per hour for 1.5 hours.

Figure 1-1: Location of the Burger Field
Prospect Well: Burger J



The drilling operations for the Burger J well would be conducted by the drill rig Noble Discoverer. The drilling operation for each discharge scenario would be conducted in three different intervals yielding a total of six (2 discharge scenarios × 3 intervals per scenario) drilling intervals as presented in **Table 1-2**.

Table 1-1: Location of the Prospect Well Burger J

Prospect Well	Area	Block	Coordinates				Water Depth (m)
			Easting (m)	Northing (m)	Latitude	Longitude	
Burger J	Posey	6912	555,036.01	7,897,424.42	N71° 10' 24.03"	W163° 28' 18.52"	43.9

Table 1-2 presents the detailed drilling operations and effluent data for the prospect well Burger J. This table presents the following data: discharge scenarios, drilling intervals, duration of drilling, depth of drilling, volume of total water based drill cuttings including washout, volume of total drilling fluids, volume of seawater added, volume of total pre-diluted effluent, and the effluent discharge rates. The estimated volumes of drill cuttings including fifty percent (50 %) washout for the six drilling intervals vary from a low of 114.62 bbls to a high of 3,702.86 bbls. The durations of drilling vary from a low of 5.2 hours to a high of 66.2 hours. The estimated volumes of the effluent after pre-dilution for the six drilling intervals vary from a low of **16,232.56** bbls to a high of **1,702,285.71** bbls. The effluent discharge rates vary from a low of **619.89** to a high of **25,714.29** bbls/hour. Cement is discharged only for the sea floor discharge scenario and is included in the volume of drill cuttings. Approximately 1,500 bbls of drilling fluids will be discharged at the end of the drilling of the well from the rig's surface pits at a rate of 1,000 bbls/hour for 1.5 hours.

Table 1-2: Drilling Operation for Burger J
DISCHARGE SCENARIOS, DRILLING INTERVALS, VOLUMES OF DRILL CUTTINGS, AND EFFLUENT DISCHARGE RATES

Discharge Scenario	Drilling Intervals	Duration of Drilling (Pumping)	Depth of Drilling	Total Water Based Drill Cuttings including 50% Washout	Total Drilling Fluids	Seawater	Total Pre-diluted Effluent (water based drill cuttings + drilling fluids + seawater)	Effluent Discharge Rate
		(Hours)	(feet)	(bbls)	(bbls)	(bbls)	(bbls)	(bbls/hour)
Sea Floor	1	66.20	225	3,702.86	10,714.29	1,687,868.57	1,702,285.71	25,714.29
	2	5.20	348	232.37	759.66	132,722.25	133,714.29	25,714.29
	3	34.40	1,434	1,070.17	3,693.78	879,807.48	884,571.43	25,714.29
Sea Surface	4	23.30	2,500	348.99	1,903.57	13,980.00	16,232.56	696.68
	5	29.00	5,316	451.73	2,464.00	17,400.00	20,315.73	700.54
	6	37.20	6,800	114.62	625.18	22,320.00	23,059.80	619.89
	Discharge from Rig's Surface Pit				1,500.00	-	1,500.00	1,000.00

A pump will be used at the sea floor during the drilling of the top hole section i.e., the drilling intervals 1, 2, and 3 for the sea floor (013) discharges. A flexible hose suction pipe will suck a large volume of sea water to move the cement, water based drill cuttings, and drilling fluids from the seafloor and will discharge from a 16.0 inch internal diameter discharge pipe at 18,000 gallons per minute (gpm). This yields into 118, 135, and 186 pre-dilution factors before discharging into the ambient for the drilling intervals 1, 2, and 3, respectively. The discharge pipe of the seafloor pump is located at 1.83 m (or 6.0 feet) above the seafloor and oriented horizontally aligned with the direction of the current, which is to the East. The sea floor pump's discharge rate of **18,000 gpm** is equivalent to **25,714.29 bbls/hour**.

The drilling fluids for the top hole section i.e., the drilling intervals 1, 2, and 3, for the sea floor (013) discharge scenario is composed of primarily sea water, which includes 30 pounds (lbs) of Bentonite and 0.5 lbs of Xanthan Gum in each barrel of sea water.

Sea water at a rate of 10 barrels per minute (bbls/min) will be added to the drill cuttings and drilling fluids before discharging into the ambient during the drilling of the bottom hole section i.e., the drilling intervals 4, 5, and 6 for the sea surface (001) discharges.

The drilling fluids for the bottom hole section i.e., the drilling intervals 4, 5, and 6, for the sea surface (001) discharge scenario is composed of primarily Sodium Chloride (NaCl) brine system. Sodium Chloride brine systems are single-salt solutions of sodium chloride and water. Saturated sodium chloride brine has a density of **1,198 kg/m^3** (or **10 lb/gal)** and used as a base drilling fluids for the bottom hole section. Barite at the rate of 1.413 lb/gal is added to the base drilling fluids to increase the weight of the drilling fluids to **1,318.13 kg/m^3** (or **11 lb/gal)** for drilling the interval 04 of the bottom hole section. Moreover, Barite at the rate of 2.83 lb/gal is added to the base drilling fluids to increase the weight of the drilling fluids to **1,438 kg/m^3** (or **12 lb/gal)** for drilling the intervals 05 and 06 of the bottom hole section.

The outer diameter of the pipe for the sea surface discharge is **15.0** inches. It runs through the main deck of the drill rig Noble Discoverer and comes out on the bottom of the ship. The drilling draft varies from **6.7** m to **7.6** m approximately. Therefore, the surface discharges occur at a depth between 6.7 m and 7.6 m from the sea surface. The internal pipe diameter of **14.25** inches was used for modeling the sea surface discharge scenario based on a 0.75 inches of total pipe wall thickness. The discharge pipe is oriented vertically downward with respect to the sea surface and discharges at approximately **6.7** m (equivalent to the drilling draft) below the sea surface for modeling the sea surface discharge scenario.

1.1 The OOC Model

The Offshore Operators Committee (OOC), a consortium of companies operating in the waters of the Gulf of Mexico, sponsored development of a model to predict the fate of effluents discharged offshore (Alam and Brandsma 2013; Brandsma and Smith, 1999). The OOC model predicts the fate of drilling mud, cuttings, or produced water discharged from a single pipe. Up to 12 classes of particulates may be contained in the effluent. Particulates may be solids or oil droplets. The model predicts the concentrations of particulates and liquid effluents in the water column and the deposition of solid particles on the sea floor. There are no restrictions on the nature of the receiving environment simulated by the OOC model. Bathymetry may be variable or constant depth. Currents and hydrography may change spatially and temporally. Sea state may change temporally. The model couples an integral plume model of initial dilution and dynamic spreading with a far-field cloud-tracking model.

The OOC model has been validated against laboratory and field data (O'Reilly et al., 1989; Smith et al, 1994; and Smith et al., 2004). The OOC model is maintained with the aid of an automated validation system. The validation system produces an HTML report documenting the results of simulating 681 experiments in twenty-five laboratory studies and four field studies (Brandsma, 2004), including a field study of cuttings deposition on the sea floor. The model has been used by several major oil companies around the globe, universities, MMS, and EPA. The model has been applied to offshore Brazil, Gulf of Mexico, Nigeria, North Sea, and Pacific Ocean.

The Graphical User Interface Discharge Offshore (GUIDO), version 7.0 software (Alam and Brandsma, 2013) for the OOC model performs pre- and post-processing for the FORTRAN based OOC model. It allows the user to prepare inputs in convenient systems of units, checks and, if necessary, adjusts inputs for consistency and submits the inputs for execution by the OOC model, in interactive or batch mode.

1.2 Settling Velocity Distribution for Solids in Drill Cuttings and Fluids

Solids in drilling discharges have a range of particle sizes (Brandsma and Smith, 1999). As a result, the settling behavior of the effluent solids is described by a distribution of settling velocities rather than a single settling velocity. The Report and User Guide (Brandsma and Smith, 1999) of the OOC Model presents examples of solids fall velocity data sets for water-based mud, water-based mud cuttings, and oil-based mud cuttings. The Report and User Guide states that these data sets can be used for modeling studies in cases where no site specific data are available on the fall velocity distribution of the effluent solids.

The dispersion and deposition numeric simulations of the cement, water based drill cuttings, and drilling fluids discharges for both the sea floor and sea surface discharge scenarios were performed using the fall velocity classes for water based mud cuttings presented in the OOC model Report and User Guide (Brandsma and Smith, 1999) for the prospect well Burger J. The volume fractions of the fall velocity classes were adjusted for the effluent for each drilling intervals based on the actual volume of the total cuttings solids present in the volumes of the total effluent. The fall velocity classes for water based mud cuttings from the Report and User Guide is presented in **Table 1-3**. The actual value of the density for the solids was used in the numeric simulations for each drilling intervals.

The dispersion and deposition numeric simulations of the drilling fluids discharges from the Rig's Surface Pits were performed using the fall velocity classes for water based mud presented in the OOC model Report and User Guide (Brandsma and Smith, 1999) for the prospect well Burger J. The volume fractions of the fall velocity classes were adjusted based on the actual volume of the total solids such as Barite present in the volume of the total effluent. The fall velocity classes for water based mud from the Report and User Guide is presented in **Table 1-4**. The actual value of the density for the solids was used in the numeric modeling of the drilling fluids discharges from the Rig's Surface Pits.

The fall velocities for different sediment particle sizes and classes are presented in **Table 1-5** (Keith Dyer, 1986).

The ambient and effluent characteristics used in the OOC models for the Burger J well are described in detailed in **Sections 2** and **3**. The modeling domain is described in **Section 4**. The modeling results are described in details in **Section 5. Section 6** presents the summary and conclusion. **Section 7** lists the references cited in this Technical Report.

Table 1-3: Fall Velocity Classes for Water Based Mud Cuttings (Brandsma and Smith, 1999)

Class	Density (g/cc)	Volume Fraction	Fall Velocity (feet/s)	Fall Velocity (cm/s)
1	2.65	0.04272	0.000004430	0.0001350264
2	2.65	0.03204	0.000055300	0.0016855440
3	2.65	0.03738	0.000716000	0.0218236800
4	2.65	0.01602	0.007638000	0.2328062400
5	2.65	0.01068	0.047480000	1.4471904000
6	2.65	0.09612	0.131600000	4.0111680000
7	2.65	0.08544	0.321400000	9.7962720000
8	2.65	0.08010	0.443500000	13.5178800000
9	2.65	0.13350	0.852200000	25.9750560000

Table 1-4: Fall Velocity Classes for Water Based Mud (Brandsma and Smith, 1999)

Class	Density (g/cc)	Volume Fraction	Fall Velocity (feet/s)	Fall Velocity (cm/s)
1	3.377000	0.000530000	3.68000E-02	1.1216640000
2	3.377000	0.002110000	1.40000E-02	0.4267200000
3	3.377000	0.010160000	2.70000E-03	0.0822960000
4	3.377000	0.010160000	2.10000E-03	0.0640080000
5	3.377000	0.007000000	1.68000E-03	0.0512064000
6	3.377000	0.007000000	1.43000E-03	0.0435864000
7	3.377000	0.005280000	9.85000E-04	0.0300228000
8	3.377000	0.002640000	4.85000E-04	0.0147828000
9	3.377000	0.004220000	2.00000E-04	0.0060960000
10	3.377000	0.003700000	9.00000E-05	0.0027432000

Table 1-5: Fall Velocities for Different Sediment Particle Size and Classes (Keith Dyer, 1986)

Sediment Size Class	Particle Size (mm)	Fall Velocity (cm/s) Keith Dyer (1986)
Chunks	> 2.0	65
Sand	0.062 - 2.0	32
Coarse Silt	0.016 - 0.062	0.32
Fine Silt	0.004 - 0.016	0.027
Clay	< 0.004	< 0.01

SECTION 2.0 AMBIENT CHARACTERISTICS

The OOC model was used for the numeric simulations of the dispersion and deposition of the cement, water based drill cuttings, and drilling fluids discharges from the prospect well **Burger J** located offshore Chukchi Sea. The required model input data for the ambient are described in this Section.

2.1 DEPTH OF WATER

The ambient water characteristics data set presented in **Table 2-1** for the planned drilling period was used for the dispersion and deposition numeric simulations of the cement, water based drill cuttings, and mud discharges using the OOC model for both the sea floor and sea surface discharge scenarios. The ambient water depth at the Burger J well site is 43.9 m. The planned drilling period is within the open water season of July thru October.

2. 2 TEMPERATURE AND SALINITY

The stratification of the ambient temperature and salinity for the open water season is presented in **Figures 2-1** and **2-2**, respectively. The temperature of the ambient water varies from 4 degrees Celsius (°C) at the surface stratum to - 0.5 °C at the bottom stratum, with a significant stratification occurring at 15 m depth. The salinity of the ambient water varies from 30 Practical Salinity Scale Unit (psu) at the surface stratum to 32 psu at the bottom stratum.

Table 2-1: Ambient Water Characteristics for the Burger Field, for the planned drilling period

Water depth	Temperature	Salinity	Current Speed	Current Direction
m	°C	psu	cm/s	
0	4.0	30.0	7.0	to the East
15	3.5	30.5	7.0	to the East
20	-0.3	31.5	7.0	to the East
43.9 - 45.7	-0.5	32.0	7.0	to the East

2.3 CURRENT SPEED

The current speed is distributed uniformly with the depth and is approximately 7 centimeter per second (cm/sec) with a prevailing direction of flow to the east for the planned drilling period

2.4 WINDS SPEED AND WAVE HEIGHT

The wind speed during the open water season steadily increases from July through October as presented in **Figure 2-3**. The approximate values for the 50-percentile rank wind speeds for July, August, September, and October are 6.8, 7.8, 9.5, and 10.25 m/s, respectively. The tentative drilling period for Burger J is mid-August to mid-September. The average value for 50-percentile rank wind speeds for the month of August and September i.e., 8.65 m/s was used for the Burger J well.

The wave height during the open water season also steadily increases from July through October as presented in **Figure 2-4**. The approximate values for the 50-percentile rank wave heights for July,

August, September, and October are 1.2, 1.4, 1.8, and 1.9 m, respectively. The average value for 50-percentile rank wave height for the month of August and September i.e., 1.6 m was used for the Burger J well.

Figure 2-1: Ambient temperature for open water season, Burger Field, Chukchi Sea

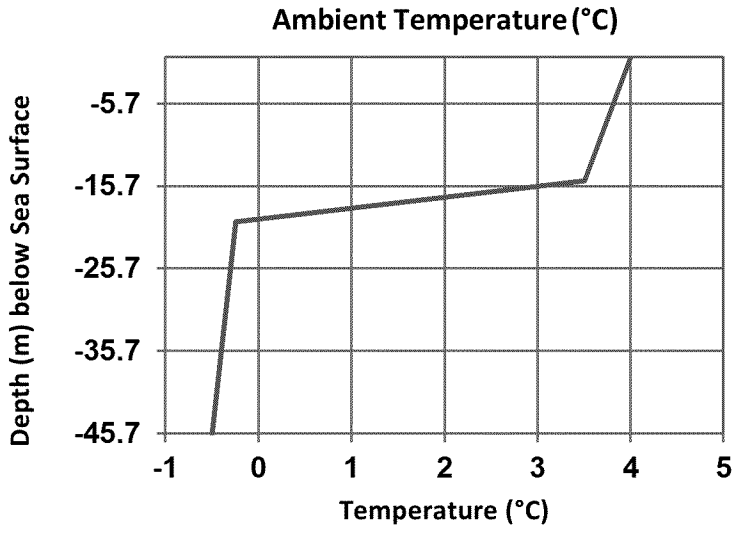


Figure 2-2: Ambient salinity for open water season, Burger Field, Chukchi Sea

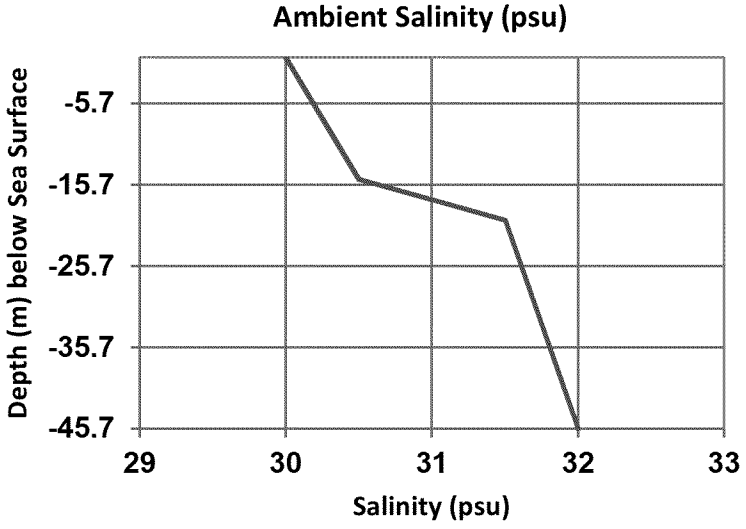


Figure 2-3: Wind speed for open water season, Burger Field, Chukchi Sea

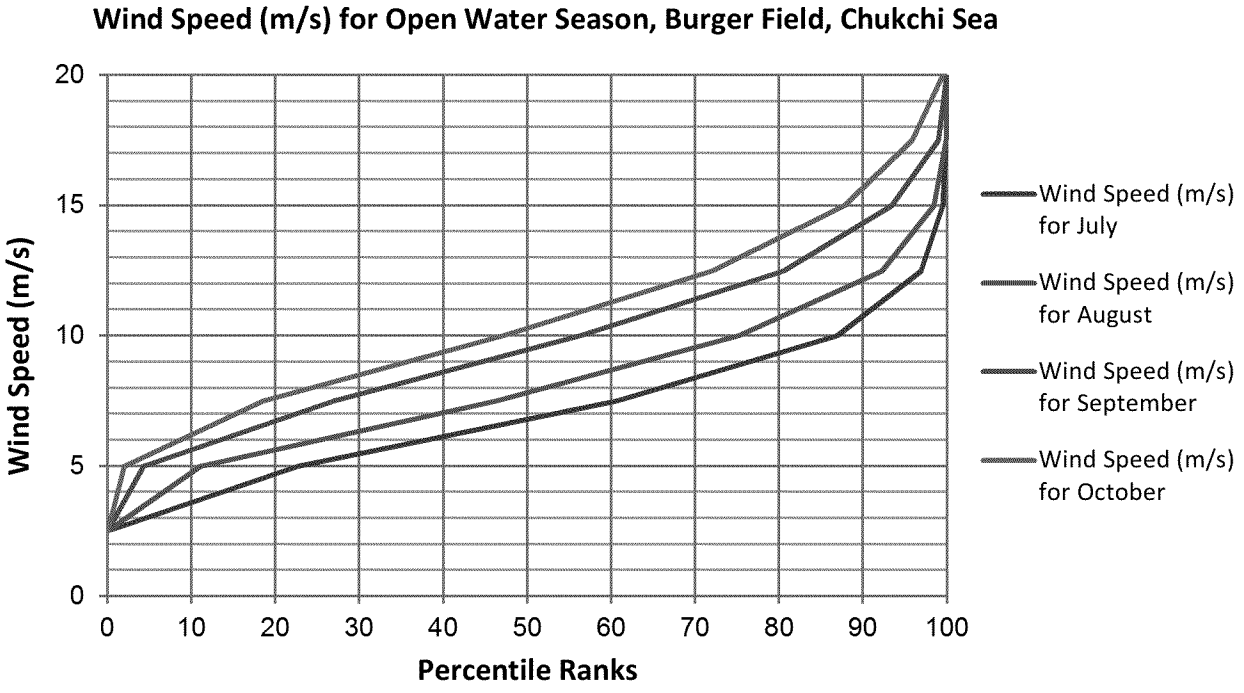
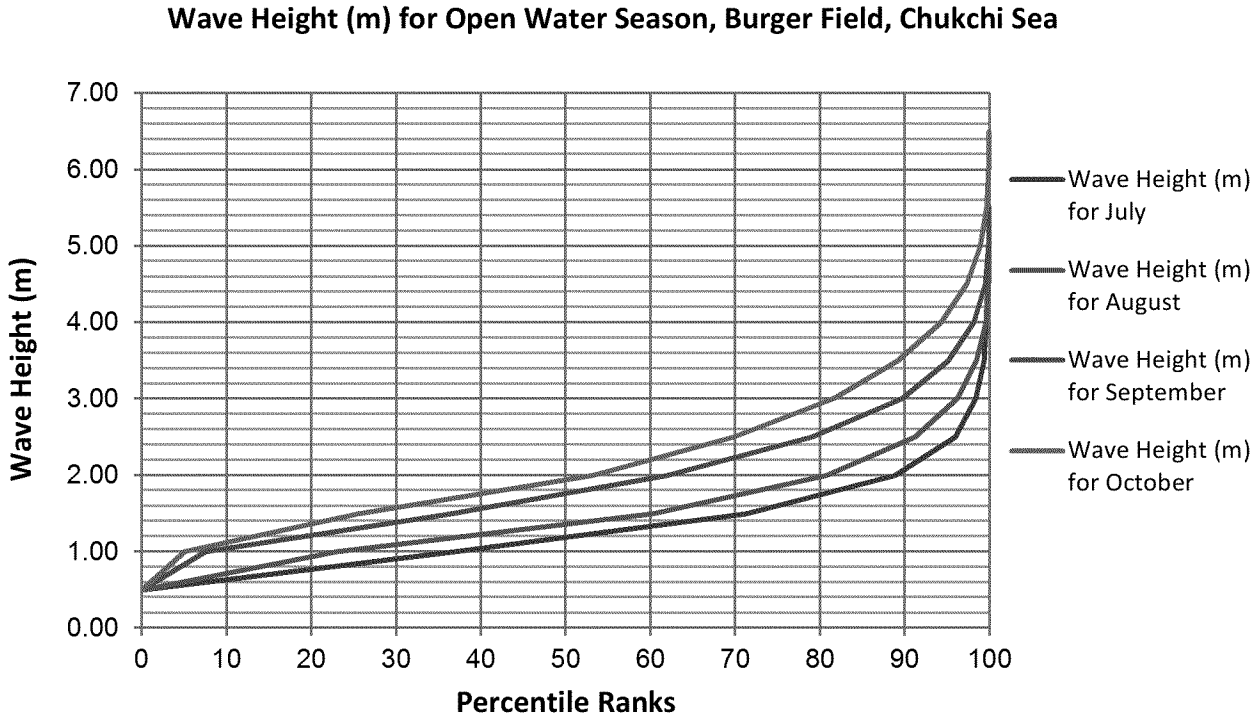


Figure 2-4: Wave height for open water season, Burger Field, Chukchi Sea



SECTION 3.0 EFFLUENT CHARACTERISTICS

The OOC model was used for the numeric simulations for the dispersion and deposition of the cement, water based drill cuttings, and drilling fluids discharges from the drilling operations at the prospect well **Burger J** located offshore Chukchi Sea. The required model input data for the effluent are described in this Section.

3.1 DISCHARGE SCENARIOS

The discharge of water based drill cuttings and drilling fluids from the drilling operations at the prospect well Burger J were simulated for two discharge scenarios: sea floor discharges and sea surface discharges as listed below. The discharge of cement is included only for the sea floor discharge scenario. No discharge of cement occurs for the sea surface discharge scenario.

- **Discharge Scenario 1**: **Sea Floor Discharges**
  Cement, drill cuttings, and drilling fluids discharges prior to the installation of the riser near the sea floor

- **Discharge Scenario 2: Sea Surface Discharges**
  Drill cuttings and drilling fluids discharges after the installation of the riser near the sea surface

  Approximately 1,500 bbls of drilling fluids will be discharged at the end of the drilling of the well from the rig's surface pits at a rate of 1,000 bbls/hour as a surface discharge for 1.5 hours.

3.2 DRILLING INTERVALS , DRILLING DURATIONS , AND EFFLUENT DISCHARGE RATES

The drilling operations for the Burger J well would be conducted by drill rig Noble Discoverer. The drilling operation for each discharge scenario would be conducted in three different intervals yielding a total of six (2 discharge scenarios × 3 intervals per scenario) drilling intervals. Moreover, approximately 1,500 bbls of drilling fluids will be discharged at the end of the drilling of the well from the rig's surface pits at a rate of 1,000 bbls/hour as a surface discharge (001) for a total duration of 1.5 hours.

The effluent characteristics from the drilling operations for each of the six drilling intervals for Burger J are presented in details in **Table 3-1**. Table 3-1 presents the detailed drilling operations and effluent data for Burger J. This table presents the following data: discharge scenarios, drilling intervals, duration of drilling, depth of drilling, volume of total water based drill cuttings including washout, volume of total drilling fluids, volume of seawater added, volume of total pre-diluted effluent, and the effluent discharge rates. The estimated volumes of drill cuttings including fifty percent (50 %) washout for the six drilling intervals vary from a low of 114.62 bbls to a high of 3,702.86 bbls. The durations of drilling vary from a low of 5.2 hours to a high of 66.2 hours. The estimated volumes of the effluent after pre-dilution for the six drilling intervals vary from a low of **16,232.56** bbls to a high of **1,702,285.71** bbls. The effluent discharge rates vary from a low of **619.89** bbls/hour to a high of **25,714.29** bbls/hour. Cement is discharged only for the sea floor discharge scenario and is included in the volume of drill cuttings. Approximately 1,500 bbls of drilling fluids will be discharged at the end of the drilling of the well from the rig's surface pits at a rate of 1,000 bbls/hour for 1.5 hours.

Table 3-1: Drilling Operation for Burger J
DISCHARGE SCENARIOS, DRILLING INTERVALS, DURATIONS OF DRILLING AND EFFLUENT DISCHARGE RATES

Discharge Scenario	Drilling Intervals	Durations of Drilling (Pumping)	Depth of Drilling	Total Water Based Drill Cuttings including 50% Washout [1]	Total Drilling Fluids	Seawater	Total Pre-diluted Effluent (water based drill cuttings + drilling fluids + seawater)	Effluent Discharge Rate
		(Hours)	(feet)	(bbls)	(bbls)	(bbls)	(bbls)	(bbls/hour)
Sea Floor	1	66.20	225	3,702.86	10,714.29	1,687,868.57	1,702,285.71	25,714.29
	2	5.20	348	232.37	759.66	132,722.25	133,714.29	25,714.29
	3	34.40	1,434	1,070.17	3,693.78	879,807.48	884,571.43	25,714.29
Sea Surface	4	23.30	2,500	348.99	1,903.57	13,980.00	16,232.56	696.68
	5	29.00	5,316	451.73	2,464.00	17,400.00	20,315.73	700.54
	6	37.20	6,800	114.62	625.18	22,320.00	23,059.80	619.89
	Discharge from Rig's Surface Pit				1,500.00	-	1,500.00	1,000.00

Notes to Tables 3-1:
1: Cement is discharged for the Sea Floor discharge scenario only and included in the Volumes of the Drill Cuttings.

The drilling fluids for the top hole section i.e., drilling intervals 1, 2, and 3, for sea floor (013) discharge scenario is composed of primarily sea water, which includes 30 pounds (lbs) of Bentonite and 0.5 lbs of Xanthan Gum in each barrel of sea water.

Sea water at a rate of 10 barrels per minute (bbls/min) will be added to the drill cuttings and drilling fluids before discharging into the ambient during the drilling of the bottom hole section i.e., the drilling intervals 4, 5, and 6 for the sea surface (001) discharge scenario.

The drilling fluids for the bottom hole section i.e., drilling intervals 4, 5, and 6, for the sea surface (001) discharge scenario is composed of primarily Sodium Chloride (NaCl) brine system. Sodium Chloride brine systems are single-salt solutions of sodium chloride and water. Saturated sodium chloride brine has a density of **1,198 kg/m^3** (or **10 lb/gal)** and used as a base drilling fluids for the bottom hole section. Barite at the rate of 1.413 lb/gal is added to the base drilling fluids to increase the weight of the drilling fluids to **1,318.13 kg/m^3** (or **11 lb/gal)** for the drilling interval 04 of the bottom hole section. Moreover, Barite at the rate of 2.83 lb/gal is added to the base drilling fluids to increase the weight of the drilling fluids to **1,438 kg/m^3** (or **12 lb/gal)** for the drilling intervals 05 and 06 of the bottom hole section.

3.3 Discharge Pipe and Height

A pump will be used at the sea floor during the drilling of the top hole section i.e., the drilling intervals 1, 2, and 3 for the sea floor (013) discharge. A flexible hose suction pipe will suck a large volume of sea water to move the cement, water based drill cuttings, and drilling fluids from the seafloor and will discharge from a 16.0 inch internal diameter discharge pipe at 18,000 gallons per minute (gpm). This yields into 118, 135, and 186 pre-dilution factors before discharging into the ambient for the drilling intervals 1, 2, and 3, respectively. The discharge pipe of the seafloor pump is located at 1.83 m (or 6.0 feet) above the seafloor and oriented horizontally aligned with the direction of the current, which is to the East. The sea floor pump's discharge rate of **18,000 gpm** is equivalent to **25,714.29 bbls/hour**.

The outer diameter of the pipe for the sea surface discharge is **15.0** inches. It runs through the main deck of the drill rig Noble Discoverer and comes out on the bottom of the ship. The internal pipe diameter of **14.25** inches was used for modeling the surface discharge scenario based on a 0.75 inches of total pipe wall thickness. The drilling draft varies from **6.7** m to **7.6** m approximately. Therefore, the surface discharges occur at a depth between 6.7 m and 7.6 m from the sea surface. The discharge pipe is oriented vertically downward with respect to the sea surface and discharges at approximately **6.7** m (equivalent to the drilling draft) below the sea surface for modeling the sea surface discharge scenario.

3.4 Fall Velocity Classes for Water Based Drill Cuttings

The dispersion and deposition numeric simulations of the cement, water based drill cuttings, and drilling fluids discharges for each well for both the sea floor and surface discharge scenarios were performed using the fall velocity classes for water based mud cuttings presented in the OOC model Report and User Guide (Brandsma and Smith, 1999) for the prospect well Burger J. The volume fractions of the fall velocity classes were adjusted for the effluent classes for each drilling intervals based on the actual volume of the total cuttings solids present in the effluent. The fall velocity classes and volume fractions for water based drill cuttings used for the Burger J well is presented in **Table 3-2**. The solids density varies from 2.65 g/cc to 3.1 g/cc, depending on the quantities of drill cuttings, Bentonite and Barite present in the effluent.

Table 3-2: Fall Velocity Classes and Volume Fractions for Water Based Drill Cuttings, Burger J

Well ID	Sediment Class in Drill Cuttings	Solids Density	Fall Velocity	Volume Fractions For Drilling Intervals					
		(g/cc)	(cm/s)	01	02	03	04	05	06
Burger J	1	Varies from 2.65 to 3.10	0.00	0.0001903	0.0001537	0.0001076	0.0021074	0.0025799	0.0005767
	2		0.00	0.0001427	0.0001153	0.0000807	0.0015805	0.0019350	0.0004325
	3		0.02	0.0001665	0.0001345	0.0000941	0.0018439	0.0022575	0.0005046
	4		0.23	0.0000714	0.0000576	0.0000403	0.0007903	0.0009675	0.0002163
	5		1.45	0.0000476	0.0000384	0.0000269	0.0005268	0.0006450	0.0001442
	6		4.01	0.0004282	0.0003459	0.0002421	0.0047416	0.0058049	0.0012976
	7		9.80	0.0003806	0.0003074	0.0002152	0.0042147	0.0051599	0.0011534
	8		13.52	0.0003568	0.0002882	0.0002017	0.0039513	0.0048374	0.0010813
	9		25.98	0.0005947	0.0004804	0.0003362	0.0065855	0.0080623	0.0018022

3.5 Fall Velocity Classes for Water Based Drilling Fluids

The dispersion and deposition numeric simulation of the drilling fluids discharges from the Rig's surface pits was performed using the fall velocity classes for water-based mud presented in the OOC model Report and User Guide (Brandsma and Smith, 1999) for the prospect well Burger J. The volume fractions of the fall velocity classes were adjusted based on the actual volume of the total solids namely Barite present in the effluent. The fall velocity classes and volume fractions for water based drilling fluids used for the Burger J well is presented in **Table 3-3**. The actual value of the density for Barite (4.1 g/cc) was used in the numeric modeling.

Table 3-3: Fall Velocity Classes and Volume Fractions for Water Based Drilling Fluids, Burger J

Well ID	Sediment Class in Drilling Fluids	Solids Density	Fall Velocity	Volume Fractions
		(g/cc)	(cm/s)	Discharge from Rig's Surface Pit
Burger J	1	4.1	1.121664	0.00082876183
	2		0.426720	0.00329941031
	3		0.082296	0.01588720795
	4		0.064008	0.01588720795
	5		0.051206	0.01094591099
	6		0.043586	0.01094591099
	7		0.030023	0.00825634429
	8		0.014783	0.00412817214
	9		0.006096	0.00659882062
	10		0.002743	0.00578569581

3.6 Effluent Densities

The sea water density was computed using the Equation of State presented by Crowley (Crowley, 1986). The computations for the effluent bulk density and the solids volume fractions for water based drill cuttings and drilling fluids for the Burger J prospect well are presented in **Table 3-4**.

Density of sea water at the surface = 1,023.80 kg/m^3.
Density of sea water at the bottom = 1,025.77 kg/m^3
Density of drill cuttings = 2,650.00 kg/m^3.
Density of drilling fluid for drilling intervals 01, 02, and 03 (top hole section) = 1,076.13 kg/m^3.
Density of drilling fluid for drilling interval 04 (bottom hole section) = 1,318.13 kg/m^3.
Density of drilling fluid for drilling intervals 05 and 06 (bottom hole section) = 1,437.87 kg/m^3.

Table 3-4: Computations of Effluent Bulk Density and Solids Volume Fractions for Burger J

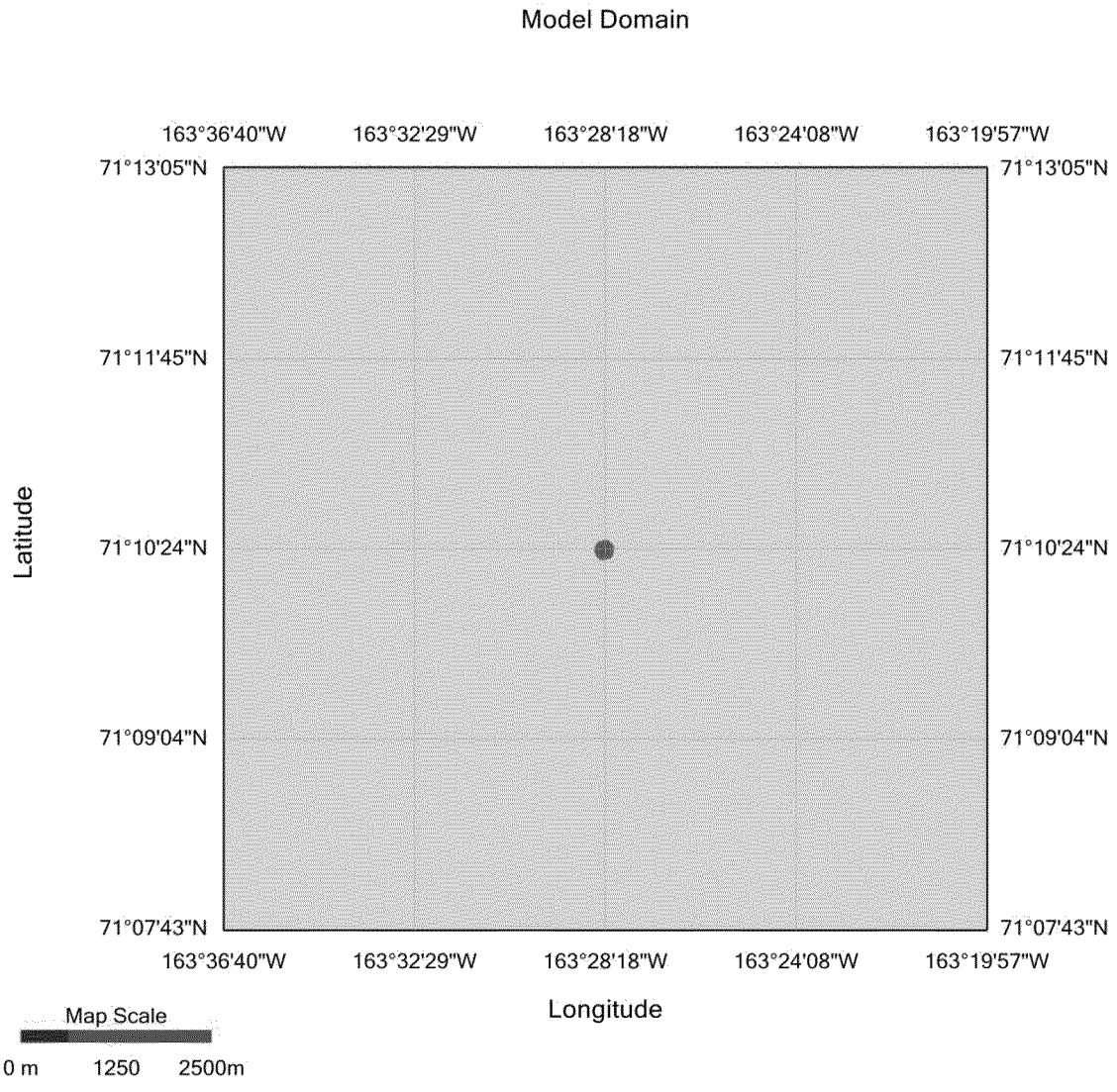
Drilling Interval	Drilling Fluids				Total Cuttings Solids or Barite in Drilling Fluids				Sea Water				Computation of Density of Effluent (Bulk Density)				Volume of Solids in Effluent	Volume Fraction of Solids in Effluent
	Density	Volume		Mass	Density	Volume		Mass	Density	Volume		Mass	Total Mass	Total Volume	Bulk Density			
	kg/m^3	bbls	m^3	kg	kg/m^3	bbls	m^3	kg	kg/m^3	bbls	m^3	kg	kg	m^3	kg/m^3	lb/gal	m^3	
01	1,076.13	10,714	1,703	1,833,122	2,650	3,703	589	1,560,074	1,025.77	1,687,869	268,350	275,264,065	278,657,262	270,642	1029.62	8.59	643.75	0.0023786
02		760	121	129,972		232	37	97,903		132,722	21,101	21,644,852	21,872,727	21,259	1028.88	8.59	40.85	0.0019214
03		3,694	587	631,975		1,070	170	450,880		879,807	139,878	143,482,370	144,565,224	140,636	1027.94	8.58	189.12	0.0013448
04	1,318.13	1,904	303	398,924		349	55	147,034	1,023.80	13,980	2,223	2,275,543	2,821,501	2,581	1093.28	9.12	67.98	0.0263420
05	1,437.87	2,464	392	563,280		452	72	190,323		17,400	2,766	2,832,221	3,585,823	3,230	1110.18	9.26	104.16	0.0322494
06		625	99	142,919		115	18	48,290		22,320	3,549	3,633,056	3,824,265	3,666	1043.11	8.71	26.43	0.0072088
Rig's Pit	1,198.30	1,376	219	262,177	4,100	124	20	80,728	-	-	-	-	342,906	238	1437.87	12.00	19.69	0.0825634

SECTION 4.0 MODELING DOMAIN

The dispersion and deposition numeric simulations of the cement, water based drill cuttings, and drilling fluids discharges for both the sea floor and sea surface discharge scenarios were performed using the OOC model as described in **Section 1**.

The model domain extends 5,000 m (5.0 km) in all directions from the discharge source. The model consists of 500 cells in the west-east direction and 500 cells in the north-south direction as well. Each cell is a 20 m × 20 m square. The well is located at the center of the modeling domain shown by a blue circle in **Figure 4-1**.

Figure 4-1: Modeling domain for the prospect well Burger J



SECTION 5.0 DISPERSION AND DEPOSITION MODELING – BURGER J

The dispersion and deposition numeric simulations of the cement, water based drill cuttings, and drilling fluids discharges from the drilling operations at the Burger J well site for both the **sea floor** and **sea surface** discharge scenarios were performed using the OOC model. Numeric simulations were carried out for the six drillings intervals for the actual drilling durations: 66.2, 5.2, 34.4, 23.3, 29.0, and 37.2 hours as presented in **Table 5-1**. Moreover, numeric simulation was also carried out for surface discharge of drilling fluids at the end of the drilling of the well from the rig's surface pits at a rate of 1,000 bbls/hour for 1.5 hours. A 360-second model time step (Δt) was used for the computer simulations of all discharges listed in Table 5-1. The solids deposition on the seabed from the below listed discharges from the six discrete drilling intervals and the rig's surface pits were compiled using GUIDO 7 for the OOC model yielding the total solids deposition loading and thickness distribution on the seabed from the drilling operations at the Burger J well site.

Table 5-1: Total Simulation Time, Model Time Step, and Discharge Rates for Burger J

Well ID	Discharge Scenario	Drilling Intervals	Duration of Drilling (Discharge)		The OOC Numeric Model Simulation			Depth of Water	Depth of Discharge	Effluent Discharge Rate
					Total Simulation Time	Model Time Step (Δt)	Count of Total Model Steps			
			Hours	Seconds	Seconds	Seconds		m	m	bbls/hour
Burger J	Sea Floor	1	66.20	238,320	238,320	360	662	43.9	42.0712	25,714.29
		2	5.20	18,720	18,720	360	52	43.9	42.0712	25,714.29
		3	34.40	123,840	123,840	360	344	43.9	42.0712	25,714.29
	Sea Surface	4	23.30	83,880	83,880	360	233	43.9	6.7056	696.68
		5	29.00	104,400	104,400	360	290	43.9	6.7056	700.54
		6	37.20	133,920	133,920	360	372	43.9	6.7056	619.89
		Rig's Surface Pits	1.5	5,400	5,400	360	15	43.9	6.7056	1,000.00

5.1 Model Results for Sea Floor Discharge Scenario – Drilling Interval 01

The OOC model predictions for the dispersion and deposition of the water based drill cuttings and drilling fluids in the near-field and far-field receiving water are presented in this Technical Report by the following effluent characteristics:

- Trajectory and shape of the discharge plume
- Total suspended solids (TSS) concentrations in the water column
- Amount of deposition (in kg/m^2) of the discharged solids on the seabed
- Spatial extent of deposition (i.e., solids thickness distribution) in centimeter (cm) of the discharged solids on the seabed

Trajectory and Shape of the Discharge Plume

The trajectory of the discharge plume is presented in **Figure 5-1**. The depth of water is 43.9 m and the discharge occurs at a depth of 42.07 m from a **16.0** inches internal diameter discharge pipe of the sea floor pump at 25,714.29 bbls/hour (or 18,000 gpm). A flexible hose suction pipe of this sea floor pump moves the muds, cuttings, and cement from the drill strings and discharges at 6.0 feet above the seafloor. The discharge pipe is located at 6.0 feet above the seafloor and oriented horizontally aligned with the direction of the current, which is to the East. Therefore, the heavier discharge plume attempts to shoot horizontally as seen in Figure 5-1 and travels to the east to a distance approximately 0.15 m only from the source before collapsing onto the sea floor due to the proximity of the plume near the sea floor. The shape and width of the discharge plume is presented in **Figure 5-2**. The width of the plume is approximately 0.5 m at a distance 0.50 m from the source.

Figure 5-1: Trajectory of the discharge plume, Burger J, Drilling Interval 01

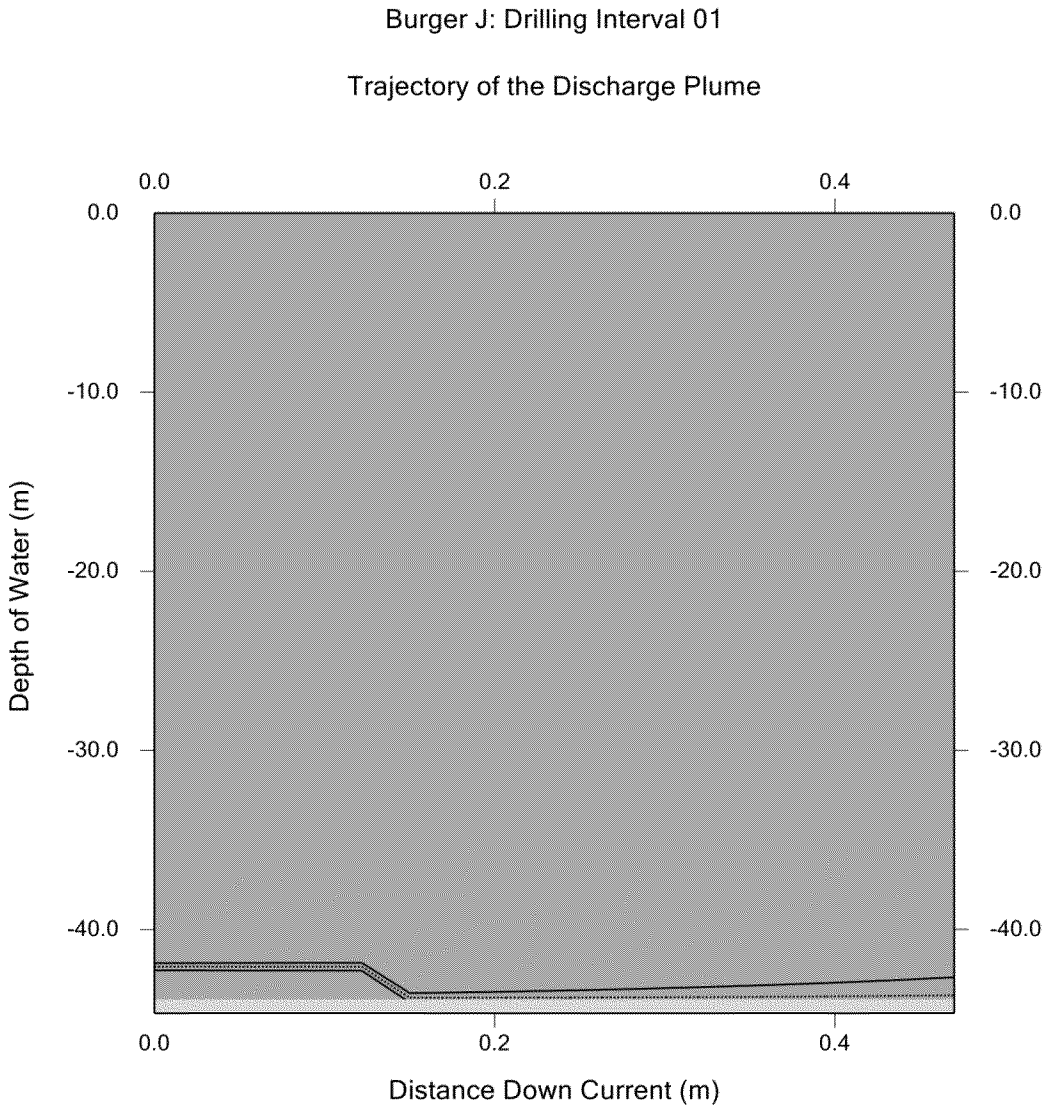
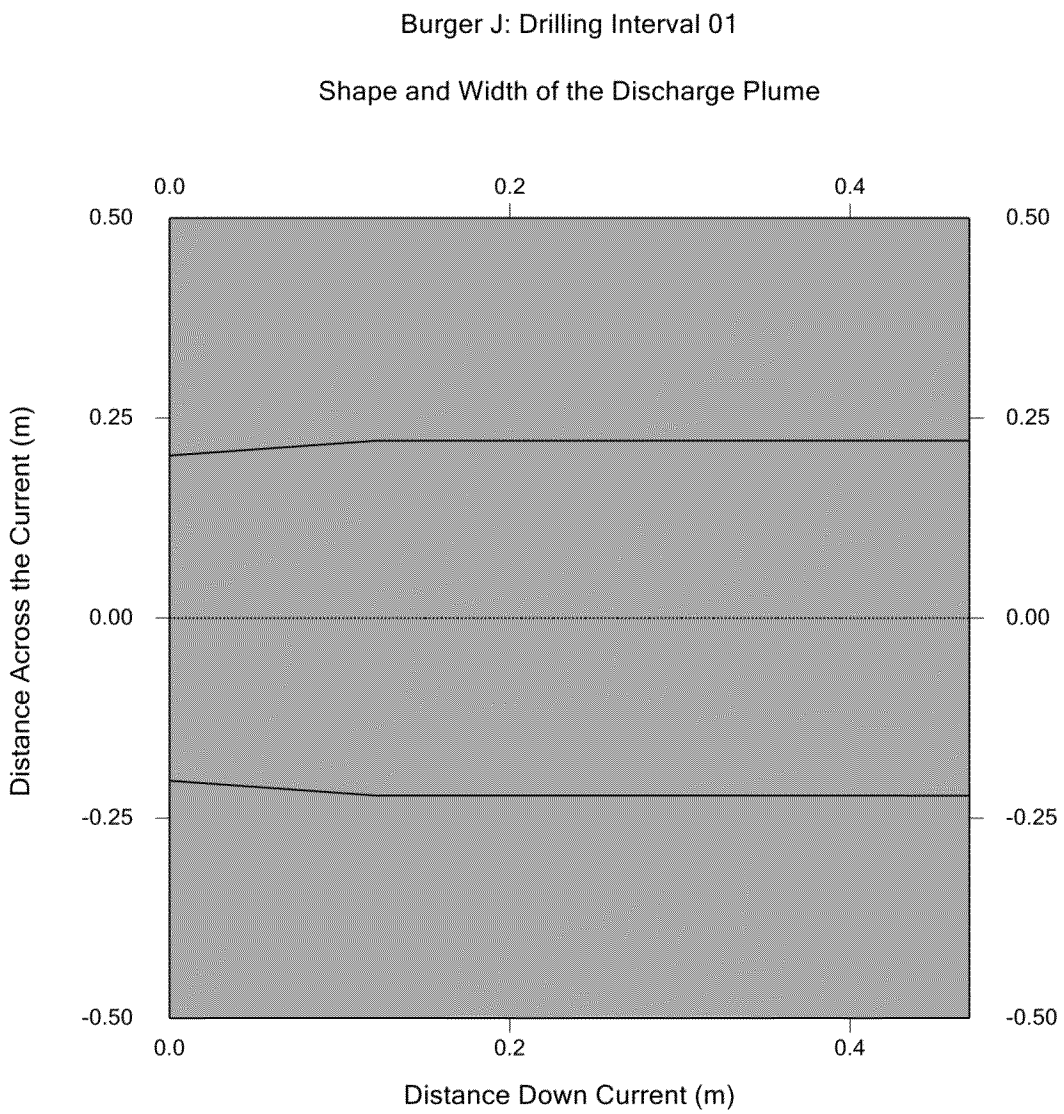


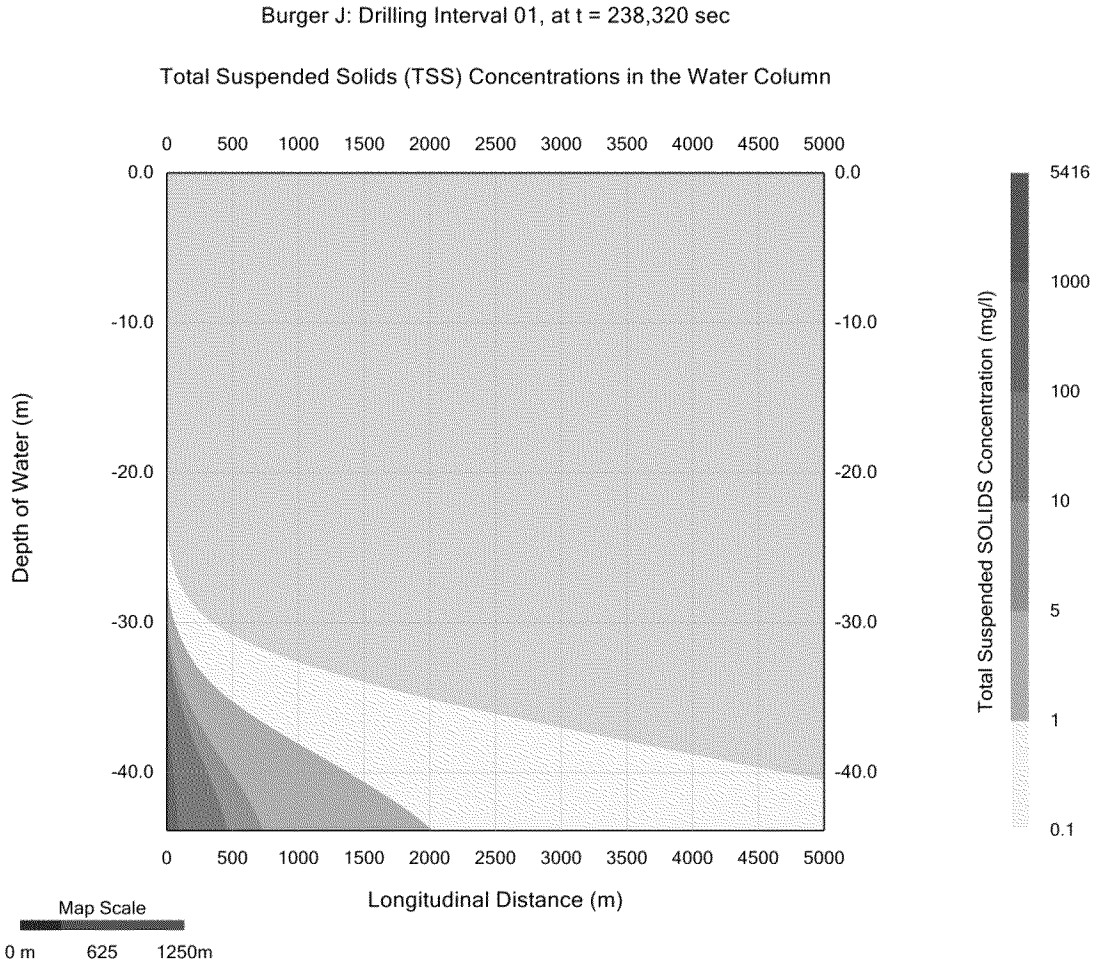
Figure 5-2: Shape and width of the discharge plume, Burger J, Drilling Interval 01



TOTAL SUSPENDED SOLIDS (TSS) CONCENTRATIONS IN THE WATER COLUMN

The total suspended solids (TSS) concentrations in the water column at time, t = 238,320 sec which is the discharge duration for this drilling interval is presented in **Figure 5-3**. The depth of water is 43.9 m at the discharge location. The maximum TSS concentration 5,416 mg/l occurs at the discharge location. It decreases to a value of 10 mg/l at a distance approximately 500 m from the discharge location. The TSS concentration varies from 10 to 5 mg/l between 500 and 800 m distances from the discharge location. The TSS concentration varies from 5 to 1 mg/l between 800 and 2,000 m distances from the discharge location. The TSS concentration is less than 1.0 mg/l beyond 2,000 m from the discharge location. The effect of the sea floor pump is visible in this Figure 5-3. The discharge plume is spreading farther horizontally to the east along the direction of the current than vertically. The TSS concentration is less than 5 mg/l at a depth approximately 30.0 m or less at or near the discharge location. The TSS concentration is less than 1.0 mg/l at a depth approximately 40.0 m or less at 1,500.0 m from the discharge location.

Figure 5-3: Total suspended solids concentrations in water column, Burger J, Drilling Interval 01

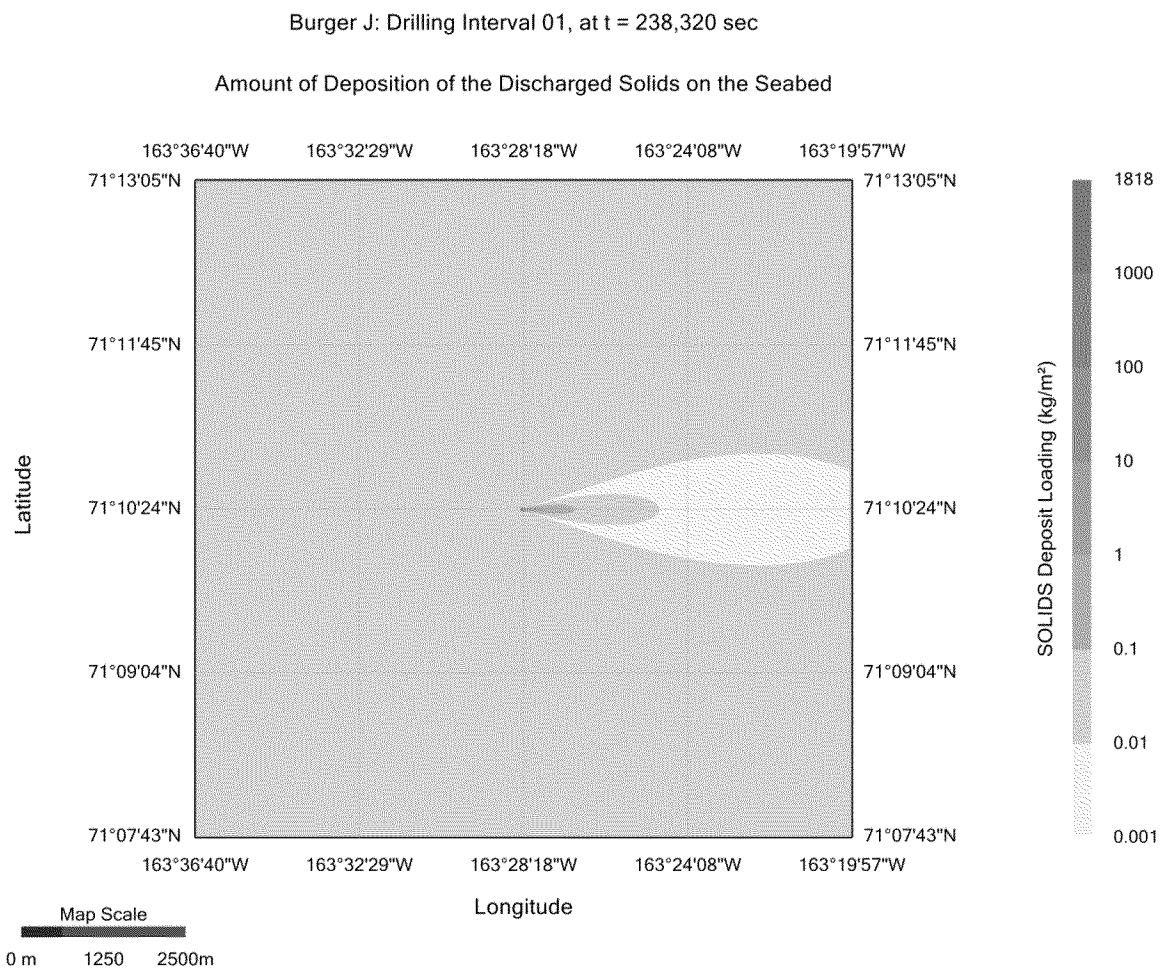


AMOUNT OF DEPOSITION (IN kg/m^2) OF THE DISCHARGED SOLIDS ON THE SEABED

The spatial extent and the amount of solids loading on the sea floor at time, t = 238,320 sec as a result of the discharge of cement, drilling fluids, and water based drill cuttings on a plan view is presented in **Figure 5-4**. The model domain extends to 5.0 kilometers (km) in all directions from the discharge location. The map scale is located at the bottom left corner of this figure. The color bar on the right provides the range of the solids loading on the sea floor in kg/m^2 by a particular color band. The maximum loading 1,818 kg/m^2 occurs at 10.0 m to the east from the discharge location. It decreases to a value of 1 kg/m^2 and 0.1 kg/m^2 at distances approximately 300 m and 800 m, respectively from the discharge location. The loading varies from 0.1 kg/m^2 to 0.01 kg/m^2 approximately between 800 and 2,000 m distances from the source. The loading is less than 0.01 kg/m^2 beyond 2,000 m from the discharge location.

The sea floor areas affected by solids deposit loading of more than 10-, 1-, 0.1- and 0.01-kg/m^2 are: 0.345, 1.289, 9.227, and 69.637 hectares (ha), respectively.

Figure 5-4: Amount of deposition of the solids on the seabed, Burger J, Drilling Interval 01



SPATIAL EXTENT OF SOLIDS THICKNESS DISTRIBUTION ON THE SEABED

The spatial extent of solids thickness of 1 cm or larger deposited on the sea floor at time, t = 238,320 sec as a result of the discharge of cement, drilling fluids, and water based drill cuttings on a plan view is presented in **Figures 5-5a** and **5-5b.** The map scale is located at the bottom left corner of these figures. The color bar on the right provides the range of the solids deposit thickness on the sea floor in cm by a particular color band. The model domain extends to 5.0 km in all directions from the discharge location as presented in Figure 5-5a. The solids deposited on the seabed of thickness 1 cm or larger as shown by a small dot, occurs on a very small surface area compare to the 10 km x 10 km map surface area shown in Figure 5-5a. The same results are presented in Figure 5-5b but shows only 480 m x 480 m seabed surface with the well at the center to show the details of the solids accumulation of 1 cm or larger on the seabed. The maximum deposit thickness of 137 cm occurs at 10.0 m to the east from the discharge location. It decreases to a value of 1 cm at a distance approximately 45 m from the discharge location.

The sea floor area affected by solids deposit thickness of 1 cm or larger is approximately a 65 m x 50 m rectangle area (or 0.324 ha to be exact) as presented in Figure 5-5b. The sea floor areas affected by deposit thickness larger than 100-, 10-, and 1-cm are: 0.091, 0.119, and 0.324 ha, respectively.

Figure 5-5a: Spatial extent of solids thickness distribution on seabed, Burger J, Drilling Interval 01

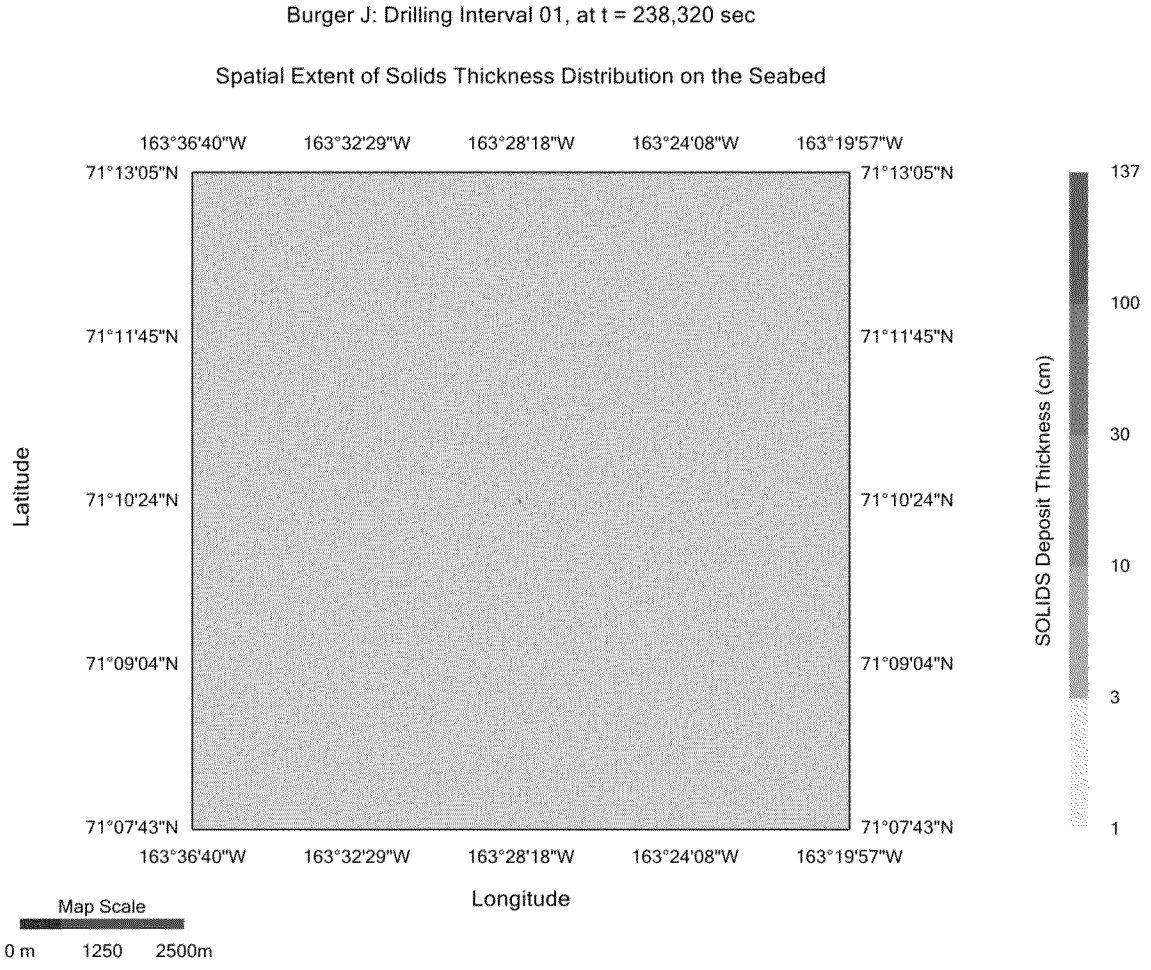
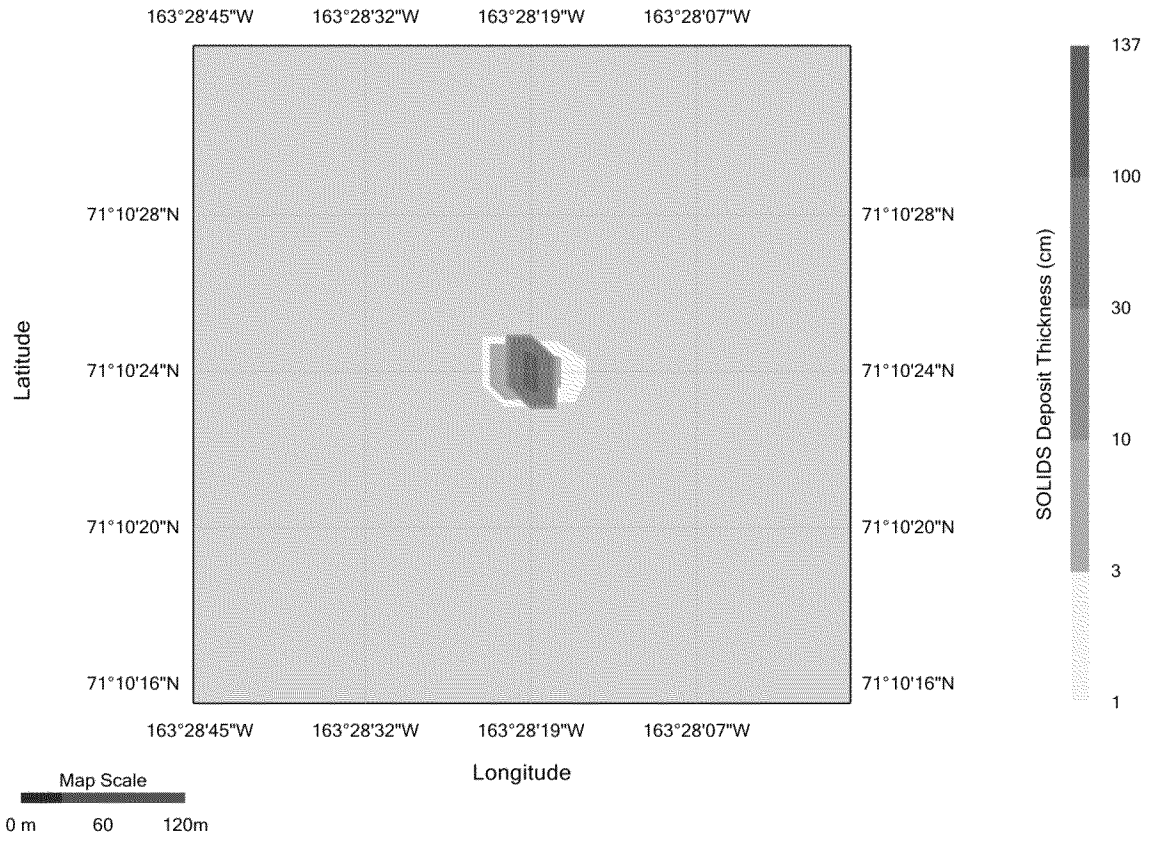


Figure 5-5b: Spatial extent of solids thickness distribution on seabed, Burger J, Drilling Interval 01 (Zoom In View)



5.2 Model Results for Sea Floor Discharge Scenario – Drilling Interval 02

Trajectory and Shape of the Discharge Plume

The trajectory of the discharge plume is presented in **Figure 5-6**. The depth of water is 43.9 m and the discharge occurs at a depth of 42.07 m from a **16.0** inches internal diameter discharge pipe of the sea floor pump at 25,714 bbls/hour (or 18,000 gpm). A flexible hose suction pipe of this sea floor pump moves the muds, cuttings, and cement from the drill strings and discharges at 6.0 feet above the seafloor. The discharge pipe is located at 6.0 feet above the seafloor and oriented horizontally aligned with the direction of the current, which is to the East. Therefore, the heavier discharge plume attempts to shoot horizontally as seen in Figure 5-6 and travels to the east to a distance approximately 0.15 m only from the source before collapsing onto the sea floor due to the proximity of the plume near the sea floor. The shape and width of the discharge plume is presented in **Figure 5-7**. The width of the plume is approximately 0.5 m at a distance 0.50 m from the source.

Figure 5-6: Trajectory of the discharge plume, Burger J, Drilling Interval 02

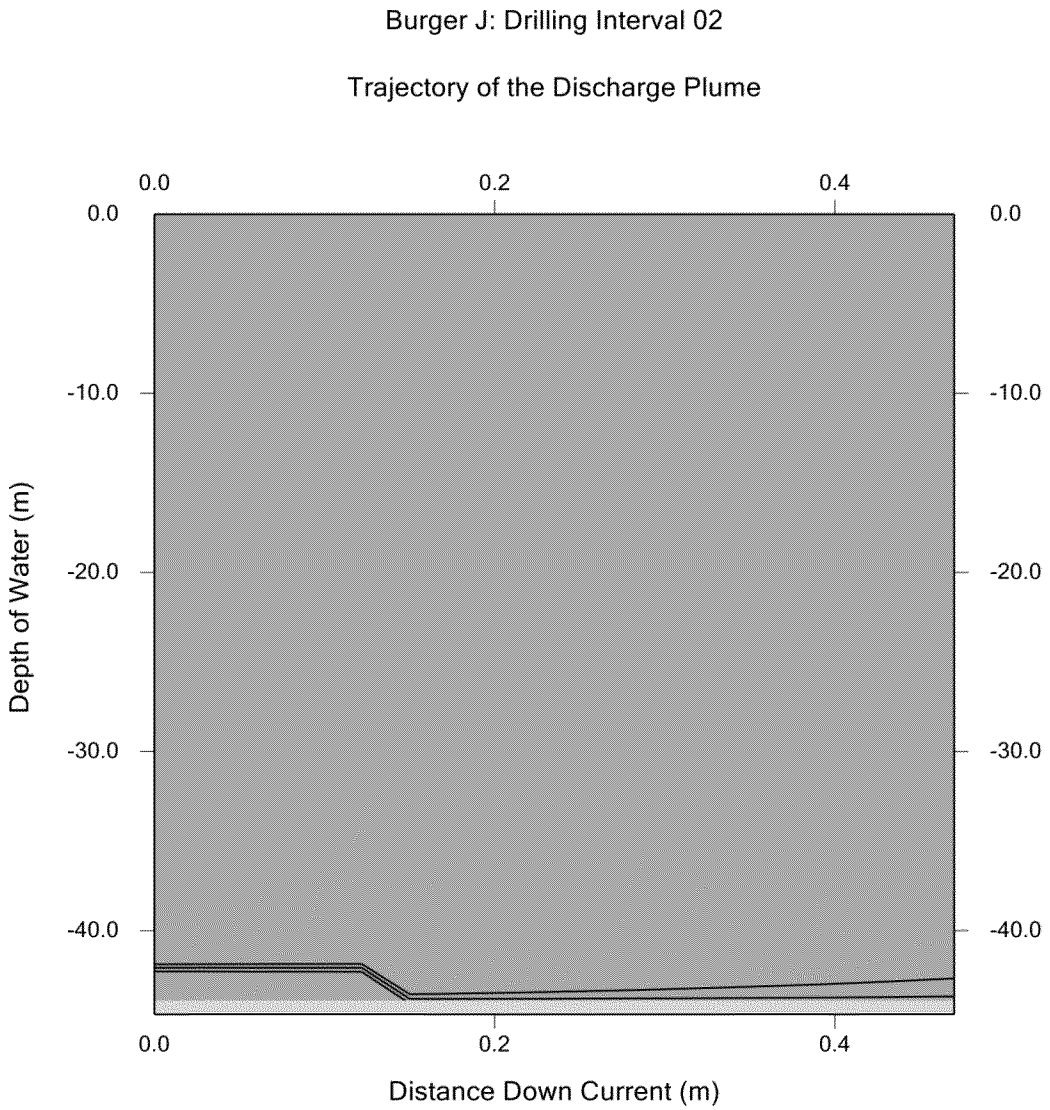
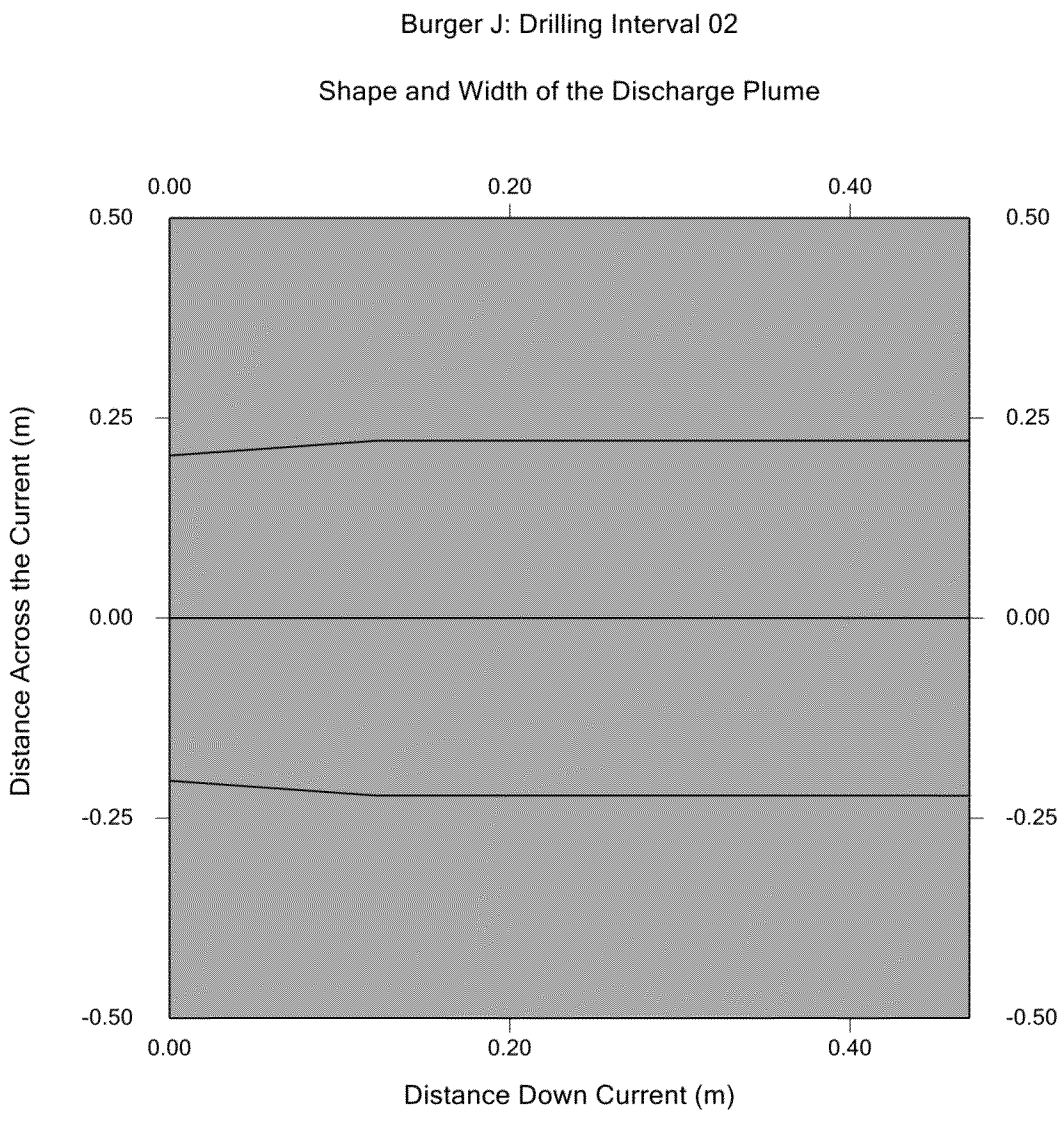


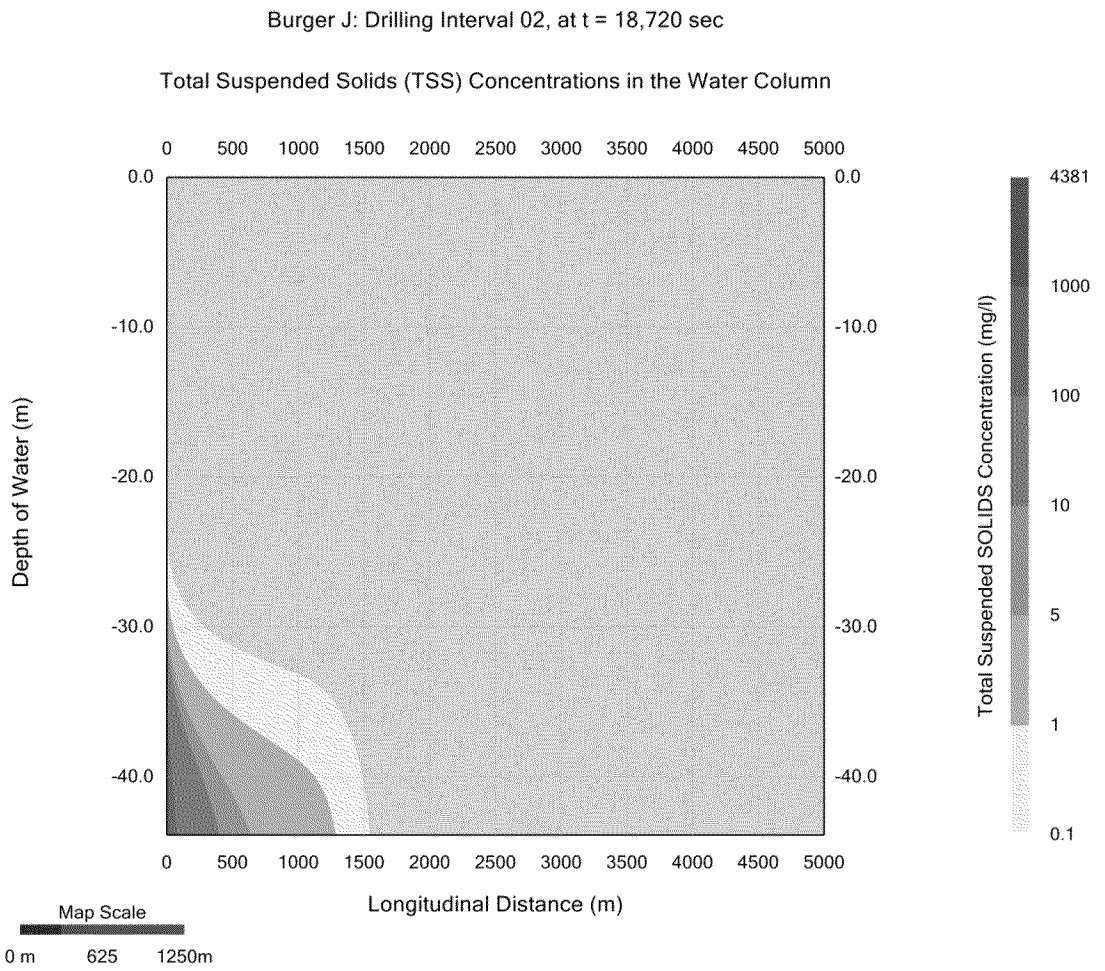
Figure 5-7: Shape and width of the discharge plume, Burger J, Drilling Interval 02



TOTAL SUSPENDED SOLIDS (TSS) CONCENTRATIONS IN THE WATER COLUMN

The total suspended solids (TSS) concentrations in the water column at time, t = 18,720 sec which is the discharge duration for this drilling interval is presented in **Figure 5-8**. The depth of water is 43.9 m at the discharge location. The maximum TSS concentration 4,381 mg/l occurs at the discharge location. It decreases to a value of 10 mg/l at a distance approximately 400 m from the discharge location. The TSS concentration varies from 10 to 5 mg/l between 400 and 650 m distances from the discharge location. The TSS concentration varies from 5 to 1 mg/l between 650 and 1,300 m distances from the discharge location. The TSS concentration is less than 1.0 mg/l beyond 1,300 m from the discharge location. The effect of the sea floor pump is visible in this Figure 5-8. The discharge plume is spreading farther horizontally to the east along the direction of the current than vertically. The TSS concentration is less than 1 mg/l at a depth approximately 30.0 m or less at or near the discharge location. The TSS concentration is less than 1.0 mg/l at a depth approximately 40.0 m or less at 1,200.0 m from the discharge location.

Figure 5-8: Total suspended solids concentrations in water column, Burger J, Drilling Interval 02

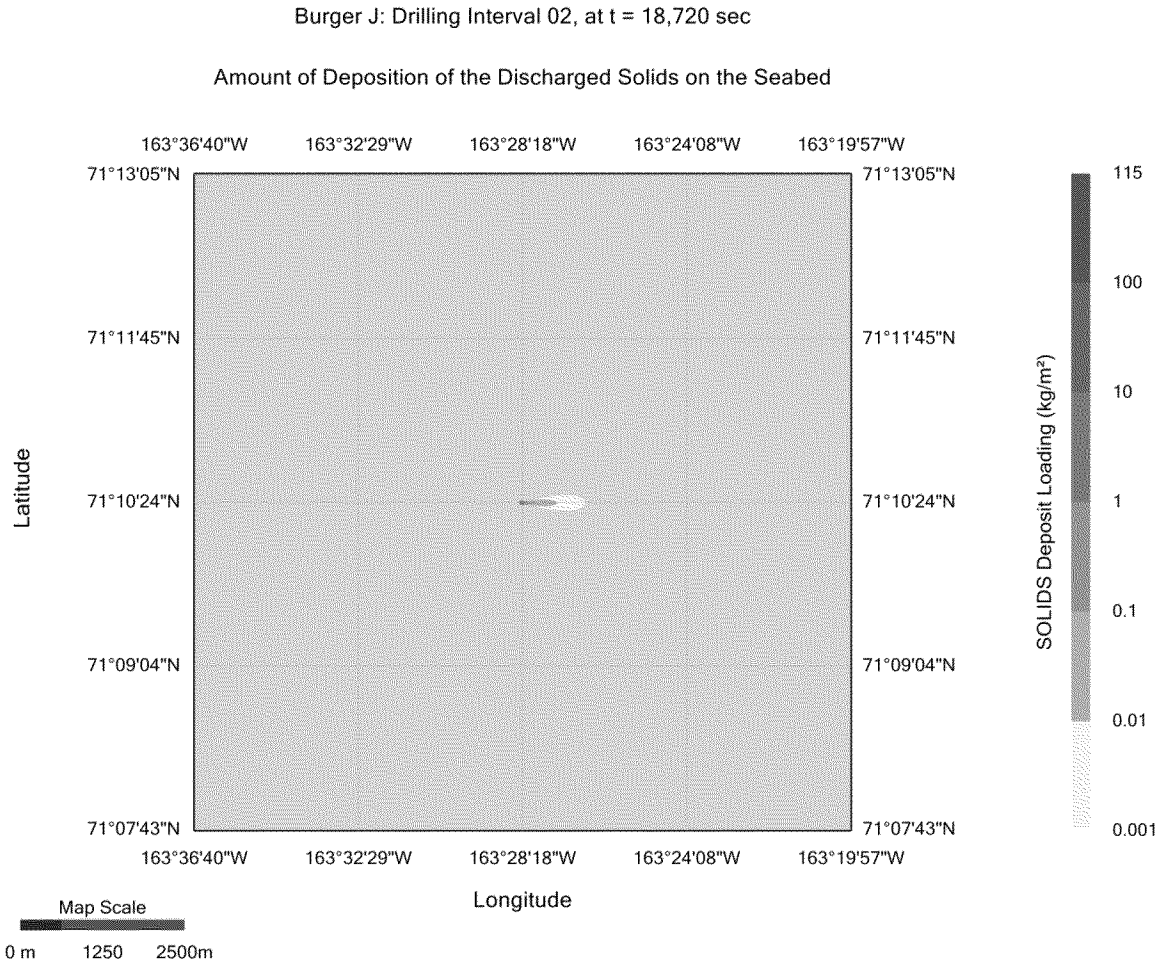


AMOUNT OF DEPOSITION (IN kg/m^2) OF THE DISCHARGED SOLIDS ON THE SEABED

The spatial extent and the amount of solids loading on the sea floor at time, t = 18,720 sec as a result of the discharge of cement, drilling fluids, and water based drill cuttings on a plan view is presented in **Figure 5-9**. The model domain extends to 5.0 kilometers (km) in all directions from the discharge location. The map scale is located at the bottom left corner of this figure. The color bar on the right provides the range of the solids loading on the sea floor in kg/m^2 by a particular color band. The maximum loading 115 kg/m^2 occurs at 10.0 m to the east from the discharge location. It decreases to a value of 1 kg/m^2 and 0.1 kg/m^2 at distances approximately 100 m and 300 m, respectively from the discharge location. The loading varies from 0.1 kg/m^2 to 0.01 kg/m^2 approximately between 300 and 600 m distances from the source. The loading is less than 0.01 kg/m^2 beyond 600 m from the discharge location.

The sea floor areas affected by solids deposit loading of more than 10-, 1-, 0.1- and 0.01-kg/m^2 are: 0.119, 0.277, 0.910, and 4.213 ha, respectively.

Figure 5-9: Amount of deposition of the solids on the seabed, Burger J, Drilling Interval 02



SPATIAL EXTENT OF SOLIDS THICKNESS DISTRIBUTION ON THE SEABED

The spatial extent of solids thickness of 1 cm or larger deposited on the sea floor at time, t = 18,720 sec as a result of the discharge of cement, drilling fluids, and water based drill cuttings on a plan view is presented in **Figures 5-10a** and **5-10b.** The map scale is located at the bottom left corner of these figures. The color bar on the right provides the range of the solids deposit thickness on the sea floor in cm by a particular color band. The model domain extends to 5.0 km in all directions from the discharge location as presented in Figure 5-5a. But the solids deposit on the seabed of thickness 1 cm or larger as shown by a small dot, occurs on a very small surface area compare to the 10 km x 10 km map surface area shown in Figure 5-10a. The same results are presented in Figure 5-10b but shows only 480 m x 480 m seabed surface with the well at the center to show the details of the solids accumulation of 1 cm or larger on the seabed. The maximum deposit thickness of 9 cm occurs at close proximity to the discharge location. It decreases to a value of 1 cm at a distance approximately 20 m from the discharge location.

The sea floor area affected by solids deposit thickness of 1 cm or larger is approximately a 30 m x 45 m rectangle area (or 0.117 ha to be exact) as presented in Figure 5-10b. The sea floor areas affected by deposit thickness larger than 5- and 1-cm are: 0.045 and 0.117 ha, respectively.

Figure 5-10a: Spatial extent of solids thickness distribution on seabed, Burger J, Drilling Interval 02

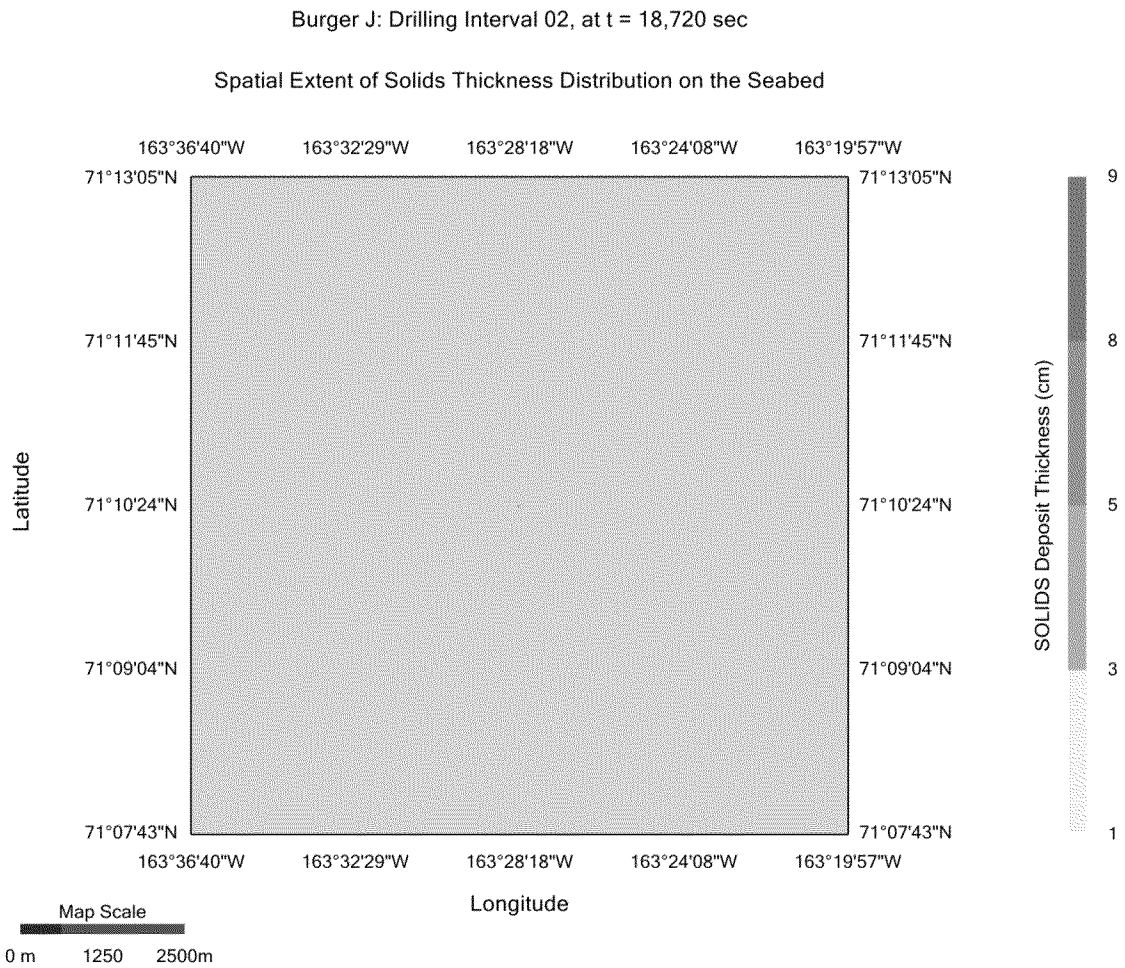
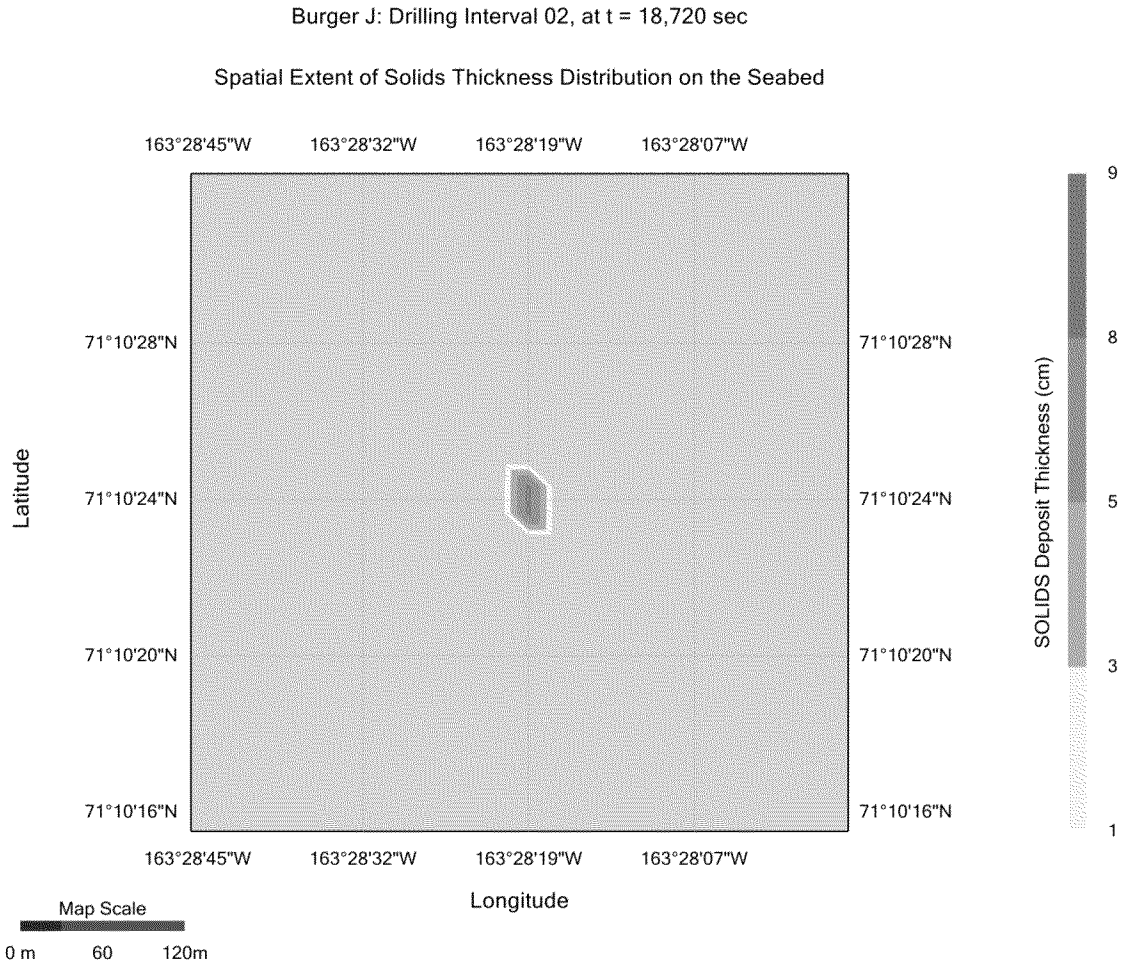


Figure 5-10b: Spatial extent of solids thickness distribution on seabed, Burger J, Drilling Interval 02 (Zoom In View)



5.3 Model Results for Sea Floor Discharge Scenario – Drilling Interval 03

Trajectory and Shape of the Discharge Plume

The trajectory of the discharge plume is presented in **Figure 5-11**. The depth of water is 43.9 m and the discharge occurs at a depth of 42.07 m from a **16.0** inches internal diameter discharge pipe of the sea floor pump at 25,714 bbls/hour (or 18,000 gpm). A flexible hose suction pipe of this sea floor pump moves the muds, cuttings, and cement from the drill strings and discharges at 6.0 feet above the seafloor. The discharge pipe is located at 6.0 feet above the seafloor and oriented horizontally aligned with the direction of the current, which is to the East. Therefore, the heavier discharge plume attempts to shoot horizontally as seen in figure below and travels to the east to a distance approximately 0.15 m only from the source before collapsing onto the sea floor due to the proximity of the plume near the sea floor. The shape and width of the discharge plume is presented in **Figure 5-12**. The width of the plume is approximately 0.5 m at a distance 0.50 m from the source.

Figure 5-11: Trajectory of the discharge plume, Burger J, Drilling Interval 03

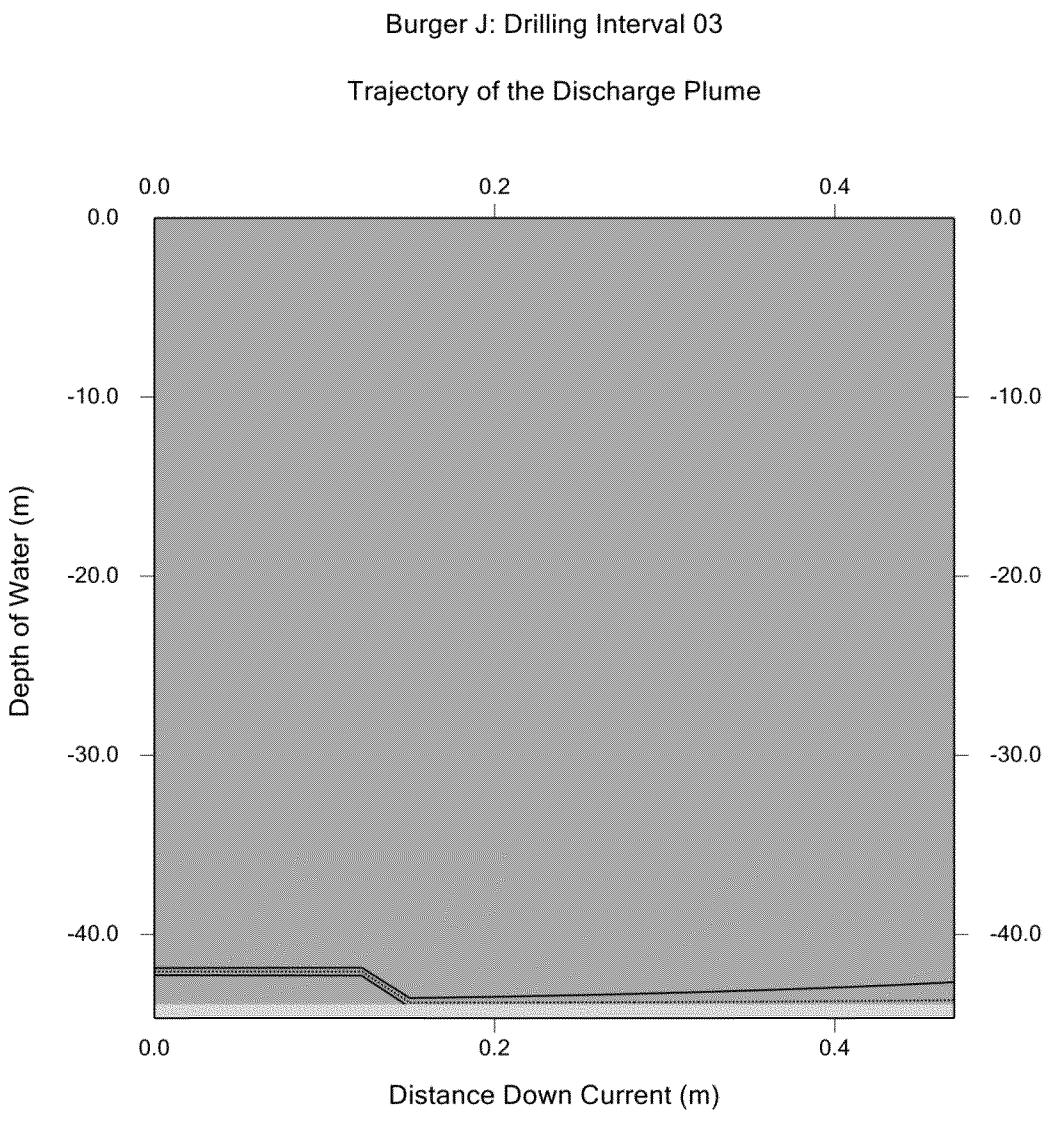
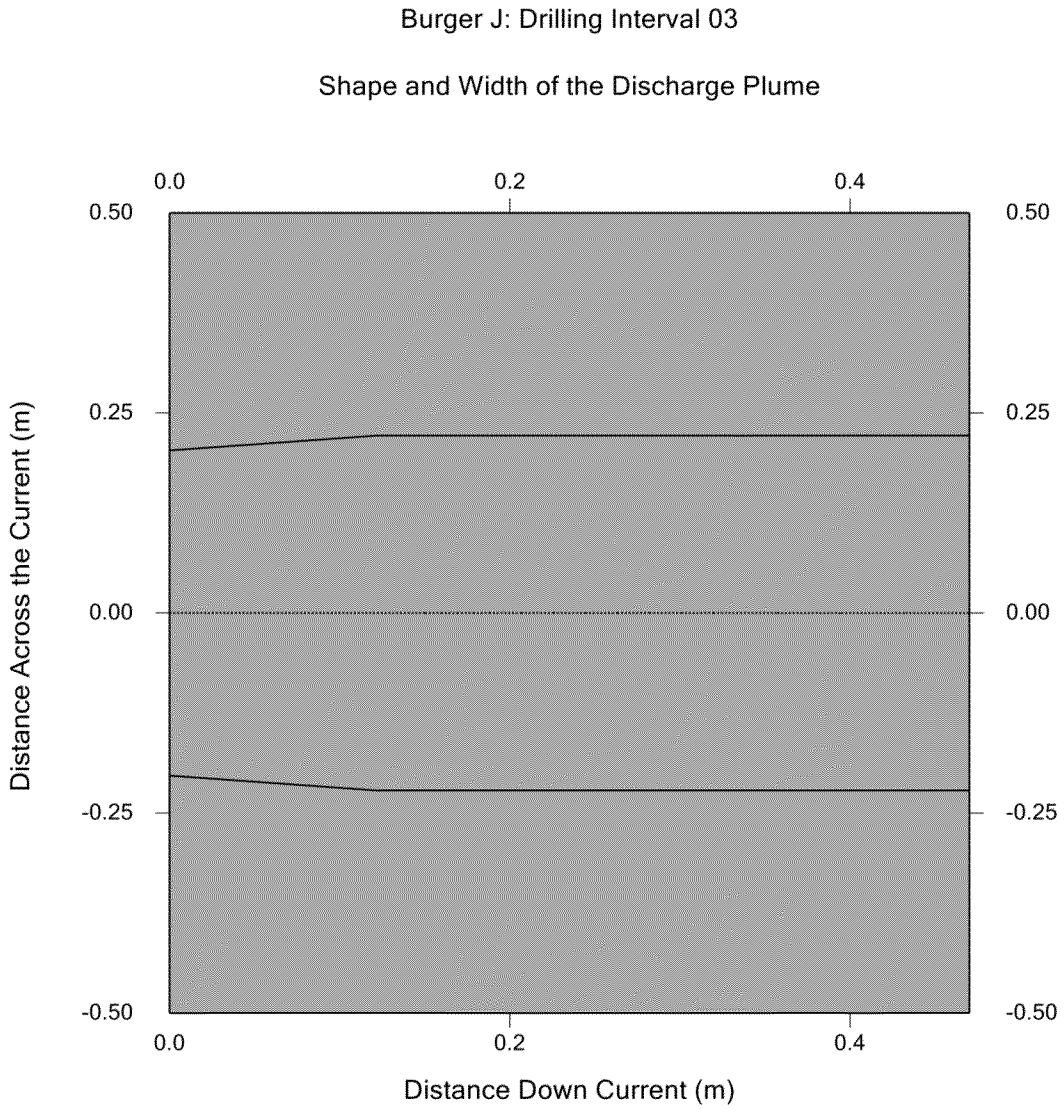


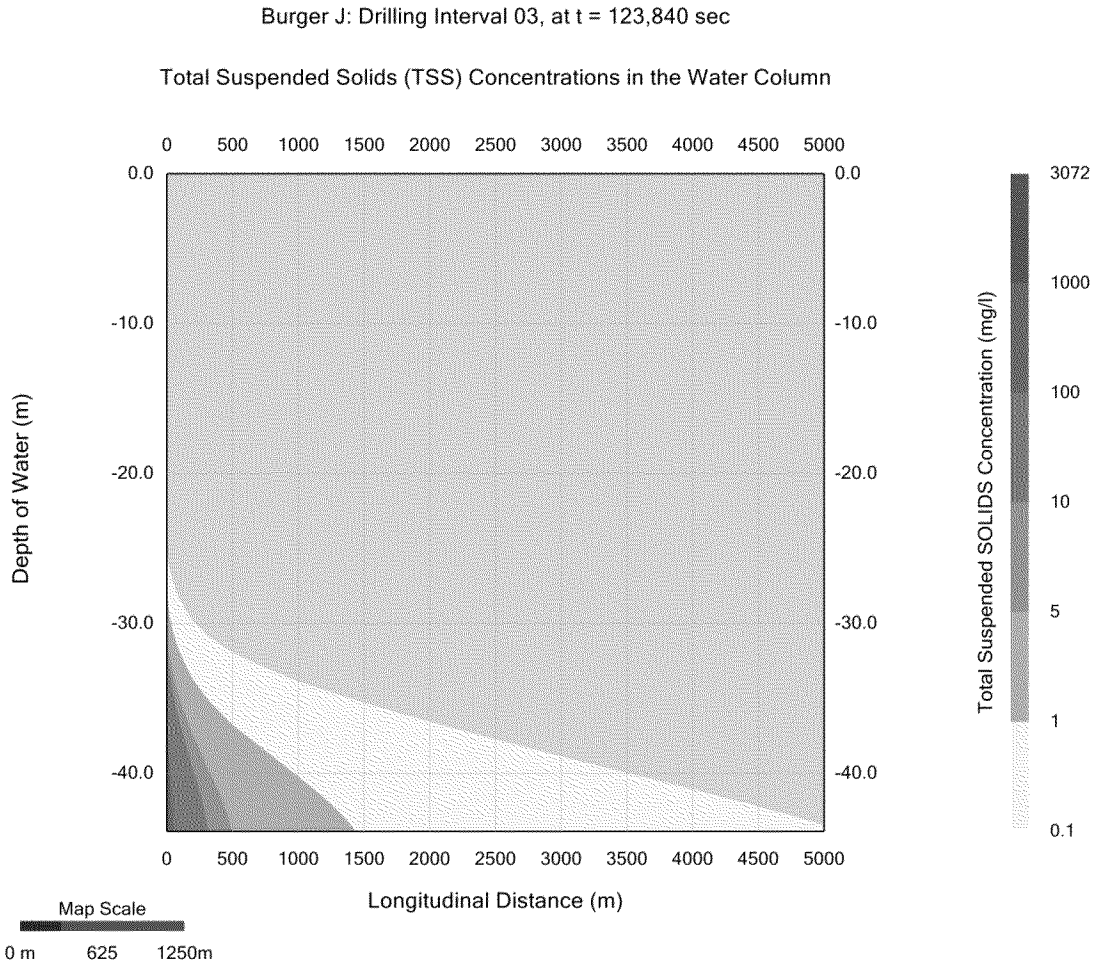
Figure 5-12: Shape and width of the discharge plume, Burger J, Drilling Interval 03



TOTAL SUSPENDED SOLIDS (TSS) CONCENTRATIONS IN THE WATER COLUMN

The total suspended solids (TSS) concentrations in the water column at time, t = 123,840 sec which is the discharge duration for this drilling interval is presented in **Figure 5-13**. The depth of water is 43.9 m at the discharge location. The maximum TSS concentration 3,072 mg/l occurs at the discharge location. It decreases to a value of 10 mg/l at a distance approximately 300 m from the discharge location. The TSS concentration varies from 10 to 5 mg/l between 300 and 500 m distances from the discharge location. The TSS concentration varies from 5 to 1 mg/l between 500 and 1,500 m distances from the discharge location. The TSS concentration is less than 1.0 mg/l beyond 1,500 m from the discharge location. The effect of the sea floor pump is visible in this Figure 5-13. The discharge plume is spreading farther horizontally to the east along the direction of the current than vertically. The TSS concentration is less than 1 mg/l at a depth approximately 30.0 m or less at or near the discharge location. The TSS concentration is less than 1.0 mg/l at a depth approximately 40.0 m or less at 1,000.0 m from the discharge location.

Figure 5-13: Total suspended solids concentrations in water column, Burger J, Drilling Interval 03

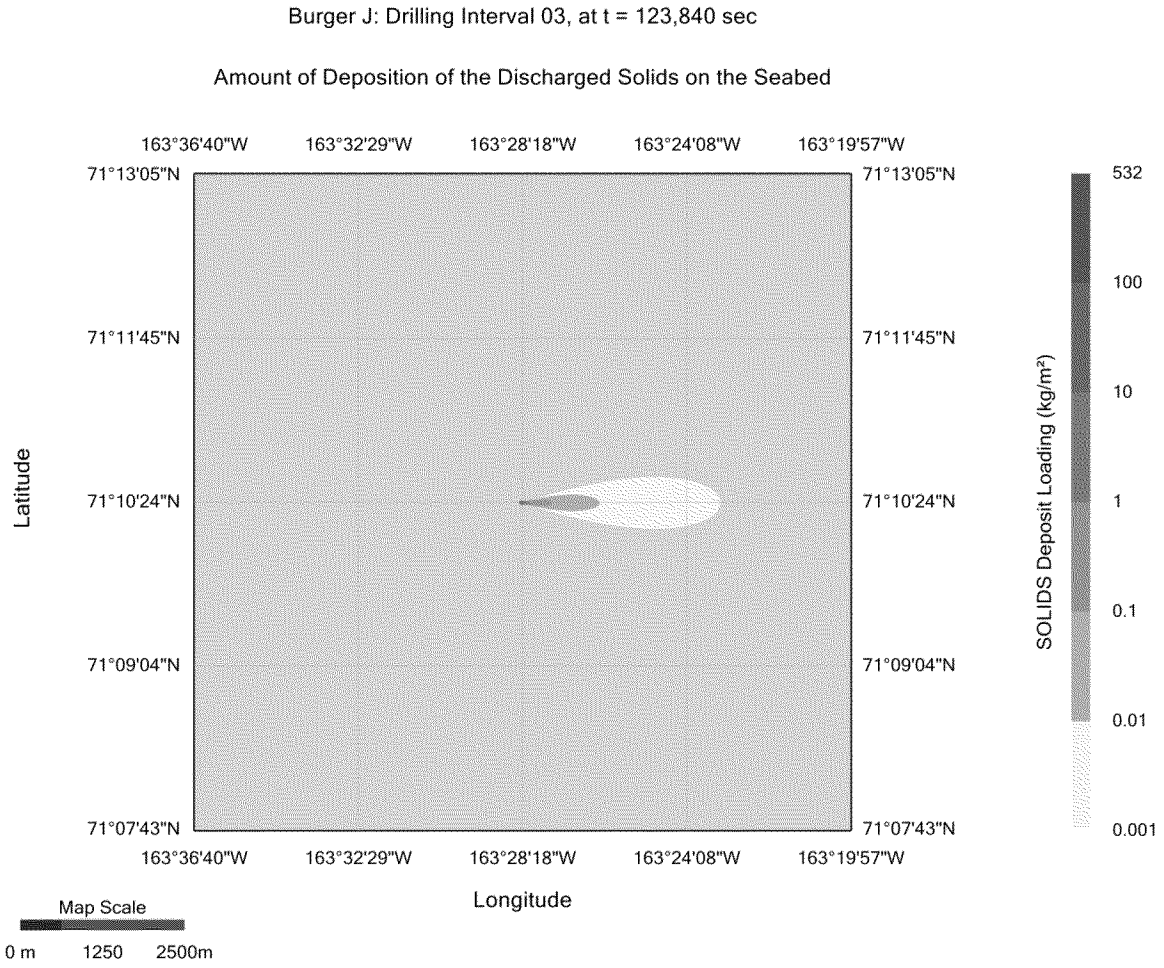


AMOUNT OF DEPOSITION (IN kg/m^2) OF THE DISCHARGED SOLIDS ON THE SEABED

The spatial extent and the amount of solids loading on the sea floor at time, t = 123,840 sec as a result of the discharge of cement, drilling fluids, and water based drill cuttings on a plan view is presented in **Figure 5-14**. The model domain extends to 5.0 kilometers (km) in all directions from the discharge location. The map scale is located at the bottom left corner of this figure. The color bar on the right provides the range of the solids loading on the sea floor in kg/m^2 by a particular color band. The maximum loading 532 kg/m^2 occurs at 10.0 m to the east from the discharge location. It decreases to a value of 1 kg/m^2 and 0.1 kg/m^2 at distances approximately 150 m and 500 m, respectively from the discharge location. The loading varies from 0.1 kg/m^2 to 0.01 kg/m^2 approximately between 500 and 1,250 m distances from the source. The loading is less than 0.01 kg/m^2 beyond 1,250 m from the discharge location.

The sea floor areas affected by solids deposit loading of more than 10-, 1-, 0.1- and 0.01-kg/m^2 are: 0.253, 0.594, 4.300, and 20.998 ha, respectively.

Figure 5-14: Amount of deposition of the solids on the seabed, Burger J, Drilling Interval 03



SPATIAL EXTENT OF SOLIDS THICKNESS DISTRIBUTION ON THE SEABED

The spatial extent of solids thickness of 1 cm or larger deposited on the sea floor at time, t = 123,840 sec as a result of the discharge of cement, drilling fluids, and water based drill cuttings on a plan view is presented in **Figures 5-15a** and **5-15b**. The map scale is located at the bottom left corner of these figures. The color bar on the right provides the range of the solids deposit thickness on the sea floor in cm by a particular color band. The model domain extends to 5.0 km in all directions from the discharge location as presented in Figure 5-15a. The solids deposited on the seabed of thickness 1 cm or larger as shown by a small dot, occurs on a very small surface area compare to the 10 km x 10 km map surface area shown in Figure 5-15a. The same results are presented in Figure 5-15b but shows only 480 m x 480 m seabed surface with the well at the center to show the details of the solids accumulation of 1 cm or larger on the seabed. The maximum deposit thickness of 40 cm occurs at 10.0 m to the east from the discharge location. It decreases to a value of 1 cm at a distance approximately 20 m from the discharge location.

The sea floor area affected by solids deposit thickness of 1 cm or larger is approximately a 45 m x 45 m rectangle area (or 0.199 ha to be exact) as presented in Figure 5-15b. The sea floor areas affected by deposit thickness larger than 10- and 1-cm are: 0.112 and 0.199 ha, respectively.

Figure 5-15a: Spatial extent of solids thickness distribution on seabed, Burger J, Drilling Interval 03

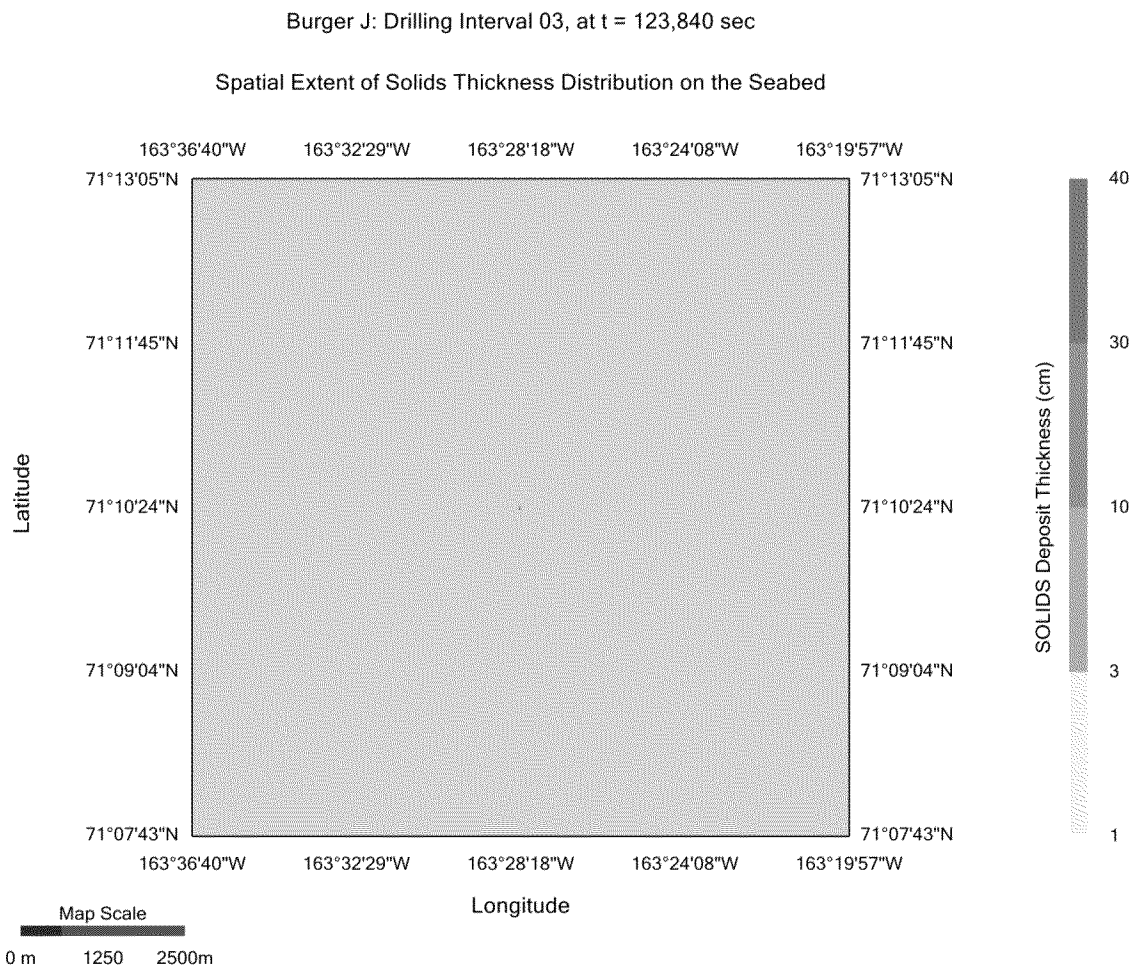
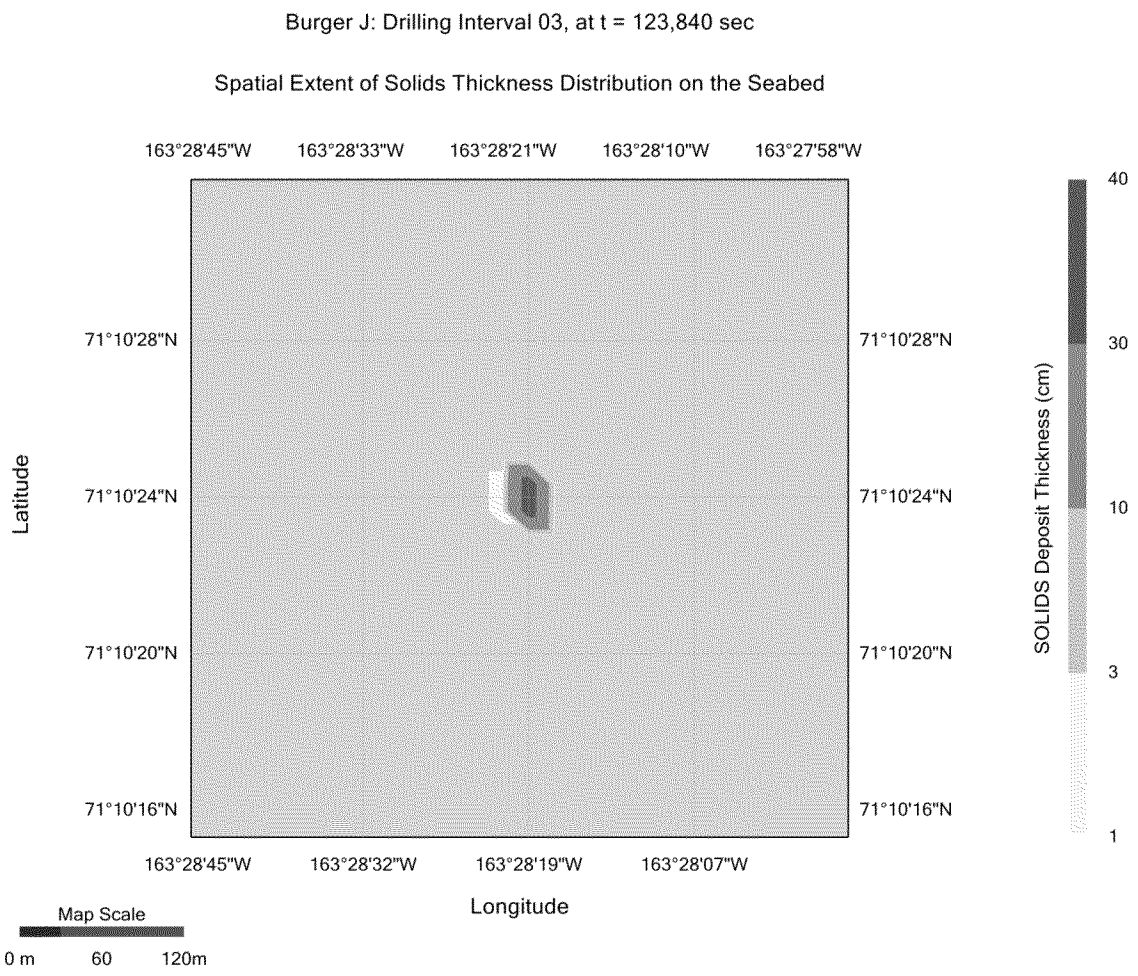


Figure 5-15b: Spatial extent of solids thickness distribution on seabed, Burger J, Drilling Interval 03 (Zoom In View)



5.4 Model Results for Sea Surface Discharge Scenario – Drilling Interval 04

Trajectory and Shape of the Discharge Plume

The trajectory of the discharge plume is presented in **Figure 5-16**. The depth of water is 43.9 m and discharge occurs at a depth of 6.7 m below the sea surface. The heavier plume travels 11.3 m from the source before collapsing into the ambient. The shape and width of the discharge plume is presented in **Figure 5-17**. The width of the plume is approximately 12.5 m at a distance 11.3 m from the source.

Figure 5-16: Trajectory of the discharge plume, Burger J, Drilling Interval 04

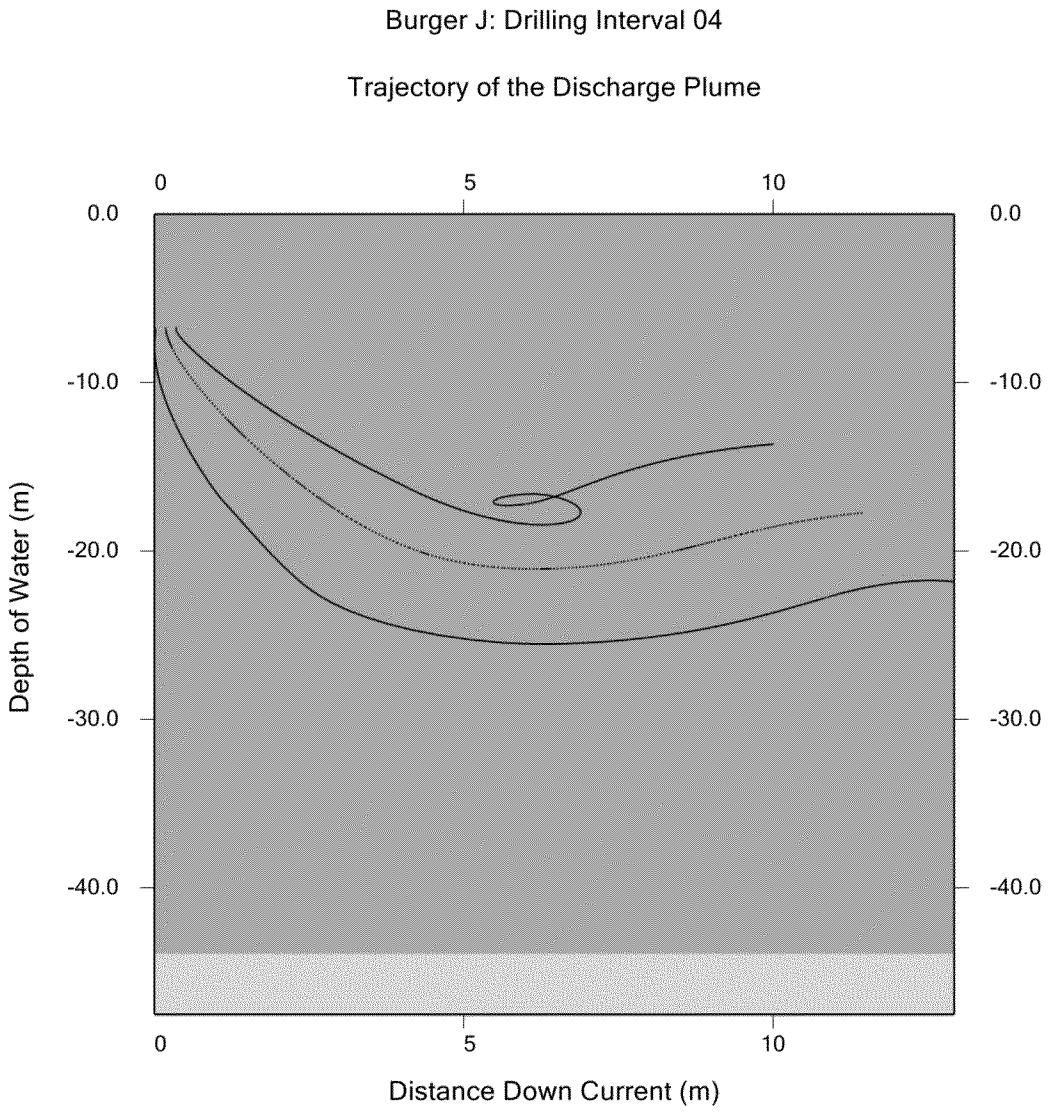
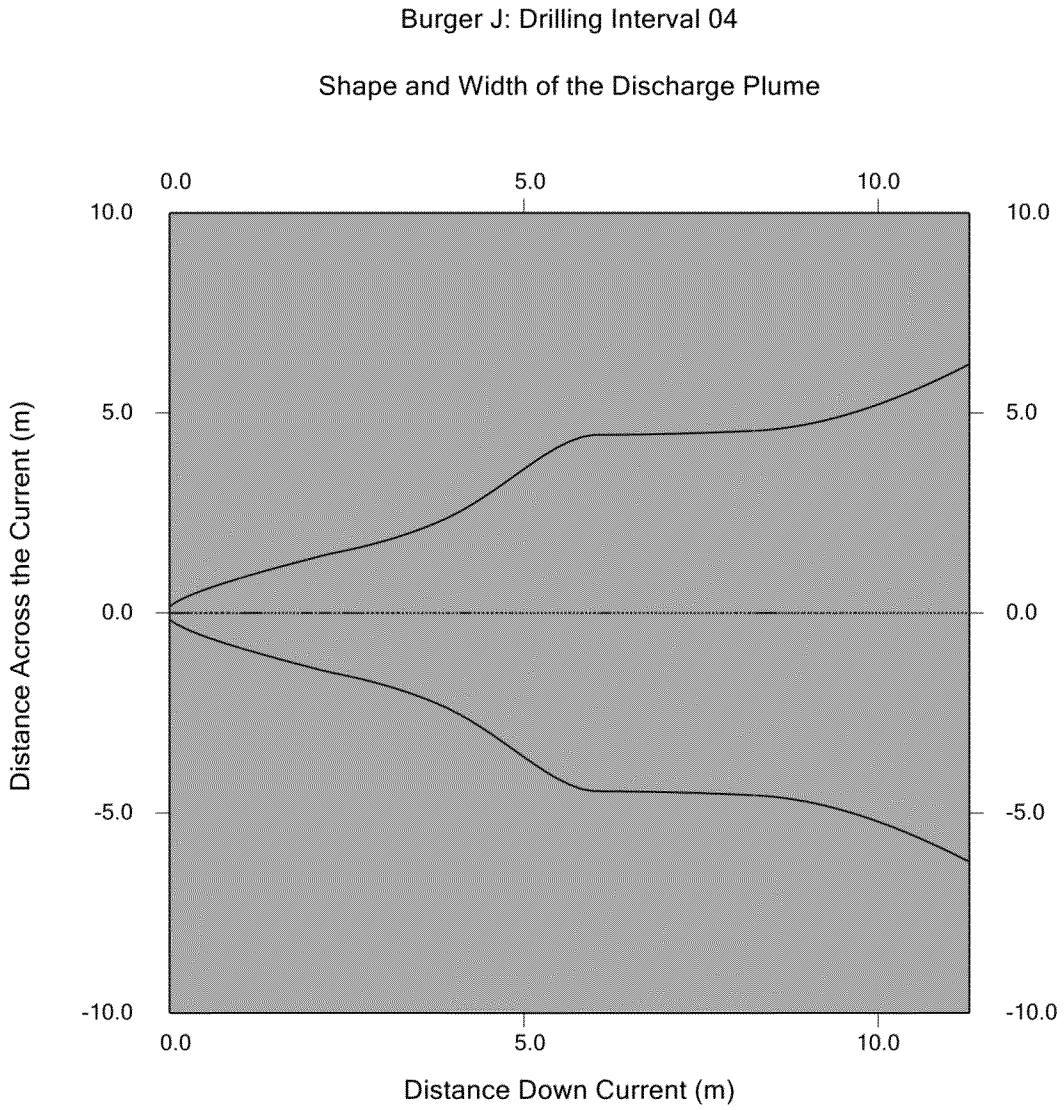


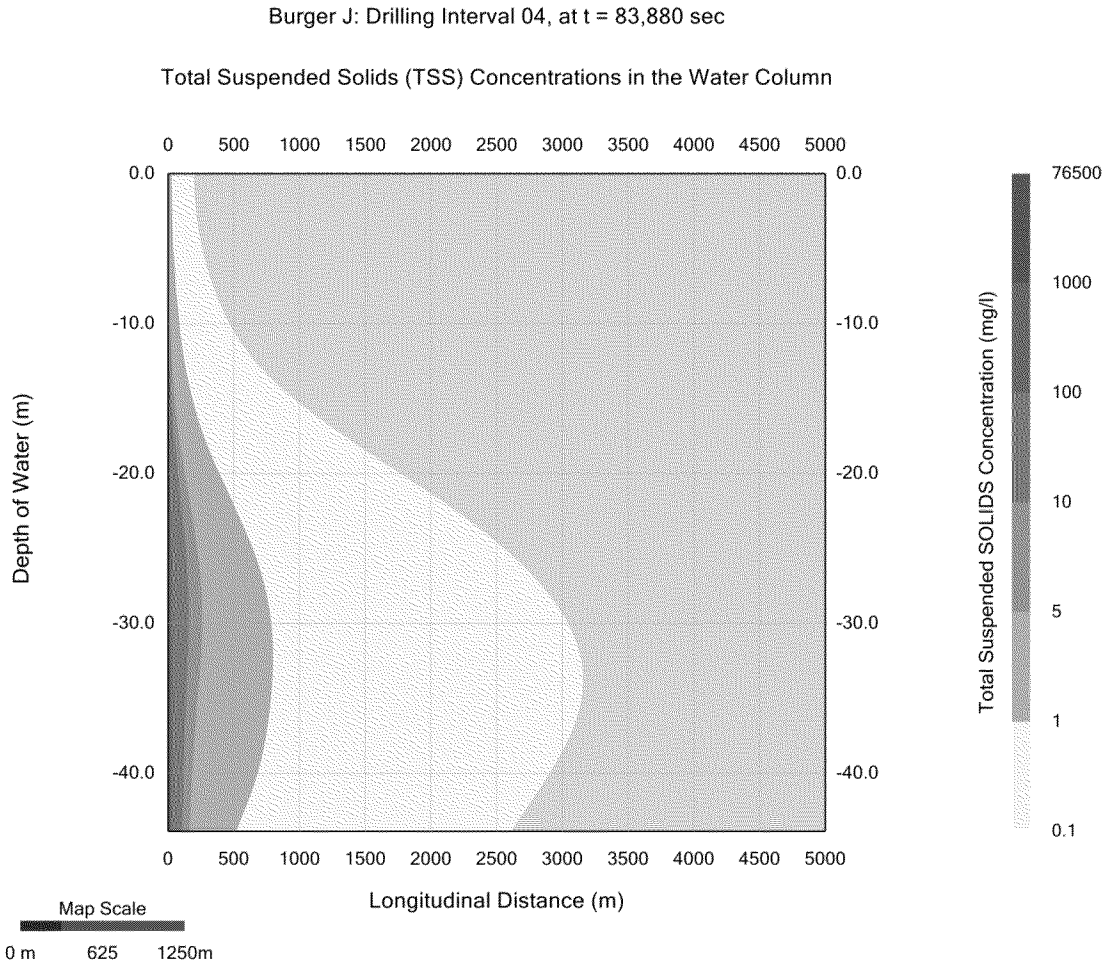
Figure 5-17: Shape and width of the discharge plume, Burger J, Drilling Interval 04



TOTAL SUSPENDED SOLIDS (TSS) CONCENTRATIONS IN THE WATER COLUMN

The total suspended solids (TSS) concentrations in the water column at time, t = 83,880 sec which is the discharge duration for this drilling interval is presented in **Figure 5-18**. The depth of water is 43.9 m at the discharge location. The maximum TSS concentration 76,500 mg/l occurs at the discharge location. It decreases to a value of 10 mg/l at a distance approximately 125 m from the discharge location. The TSS concentration varies from 10 to 5 mg/l between 125 and 200 m distances from the discharge location. The TSS concentration varies from 5 to 1 mg/l between 200 and 500 m distances from the source. The TSS concentration is less than 1.0 mg/l beyond 500 m from the discharge location.

Figure 5-18: Total suspended solids concentrations in water column, Burger J, Drilling Interval 04

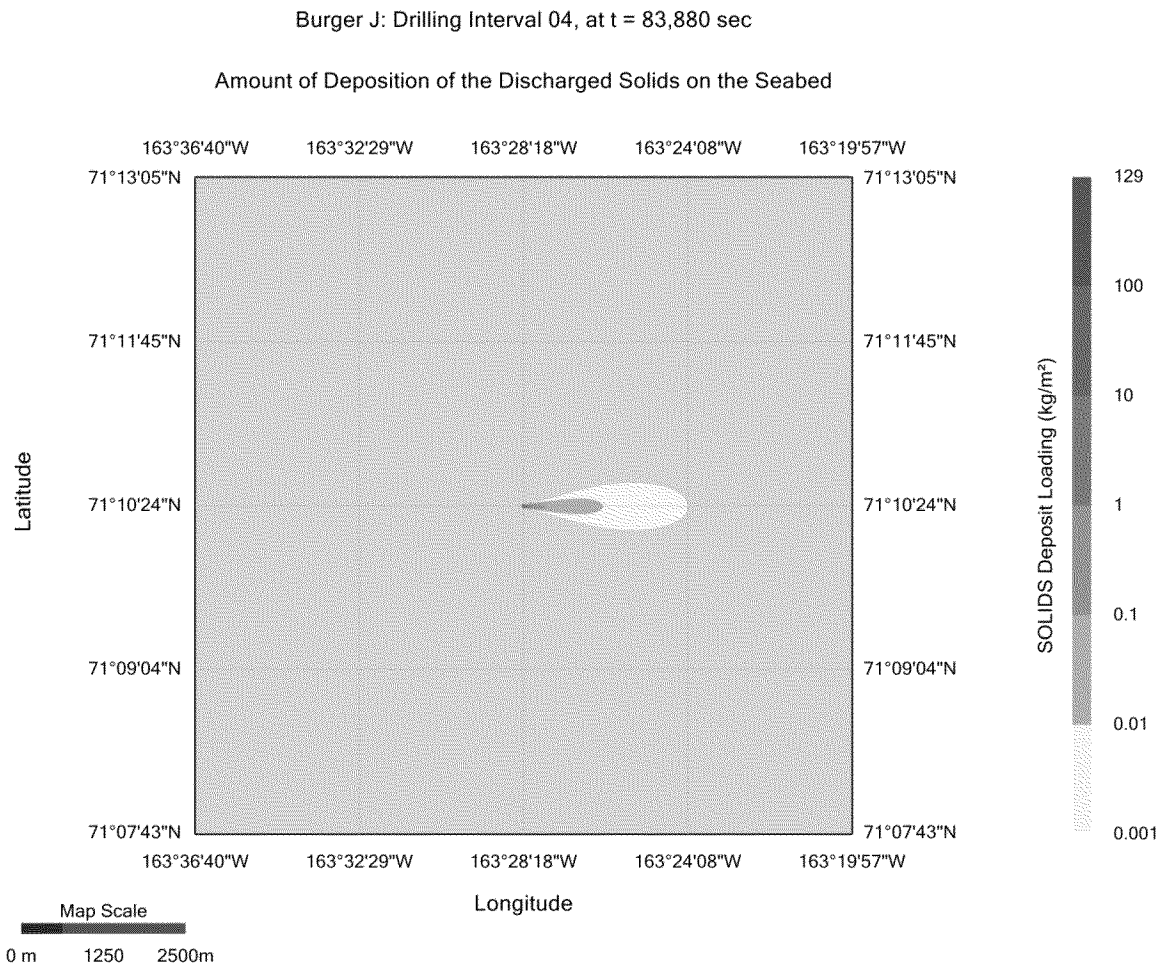


AMOUNT OF DEPOSITION (IN kg/m^2) OF THE DISCHARGED SOLIDS ON THE SEABED

The spatial extent and the amount of solids loading on the sea floor at time, t = 83,880 sec as a result of the discharge of drilling fluids and water based drill cuttings on a plan view is presented **in Figure 5-19.** The model domain extends to 5.0 km in all directions from the discharge location. The map scale is located at the bottom left corner of this figure. The color bar on the right provides the range of the solids loading on the sea floor in kg/m^2 by a particular color band. The maximum loading 129 kg/m^2 occurs at 10.0 m to the east from the discharge location. It decreases to a value of 1 kg/m^2 and 0.1 kg/m^2 at distances approximately 150 m and 350 m, respectively from the discharge location. The loading varies from 0.1 kg/m^2 to 0.01 kg/m^2 approximately between 350 m and 1,250 m distances from the discharge location. The loading is less than 0.01 kg/m^2 beyond 1,250 m from the discharge location.

The sea floor areas affected by solids deposit loading of more than 10-, 1-, 0.1- and 0.01-kg/m^2 are: 0.268, 0.658, 3.190, and 21.039 ha, respectively.

Figure 5-19: Amount of deposition of the solids on the seabed, Burger J, Drilling Interval 04



SPATIAL EXTENT OF SOLIDS THICKNESS DISTRIBUTION ON THE SEABED

The spatial extent of solids thickness of 1 cm or larger deposited on the sea floor at time, t = 83,880 sec as a result of the discharge of drilling fluids and water based drill cuttings on a plan view is presented in **Figures 5-20a** and **5-20b**. The map scale is located at the bottom left corner of these figures. The color bar on the right provides the range of the solids deposit thickness on the sea floor in cm by a particular color band. The model domain extends to 5.0 km in all directions from the discharge location as presented in Figure 5-20a. The solids deposited on the seabed of thickness 1 cm or larger as shown by a small dot, occurs on a very small surface area compare to the 10 km x 10 km map surface area shown in Figure 5-20a. The same results are presented Figure 5-20b but shows only 480 m x 480 m seabed surface with the well at the center to show the details of the solids accumulation of 1 cm or larger on the seabed. The maximum deposit thickness of 9 cm occurs at 10.0 m to the east from the discharge location. It decreases to a value of 1 cm at a distance approximately 45 m from the discharge location.

The sea floor area affected by solids deposit thickness of 1 cm or larger is approximately a 60 m x 45 m rectangle area (or 0.250 ha to be exact) as presented in Figure 5-20b. The sea floor areas affected by deposit thickness larger than 5- and 1-cm are: 0.066 and 0.250 ha, respectively.

Figure 5-20a: Spatial extent of solids thickness distribution on seabed, Burger J, Drilling Interval 04

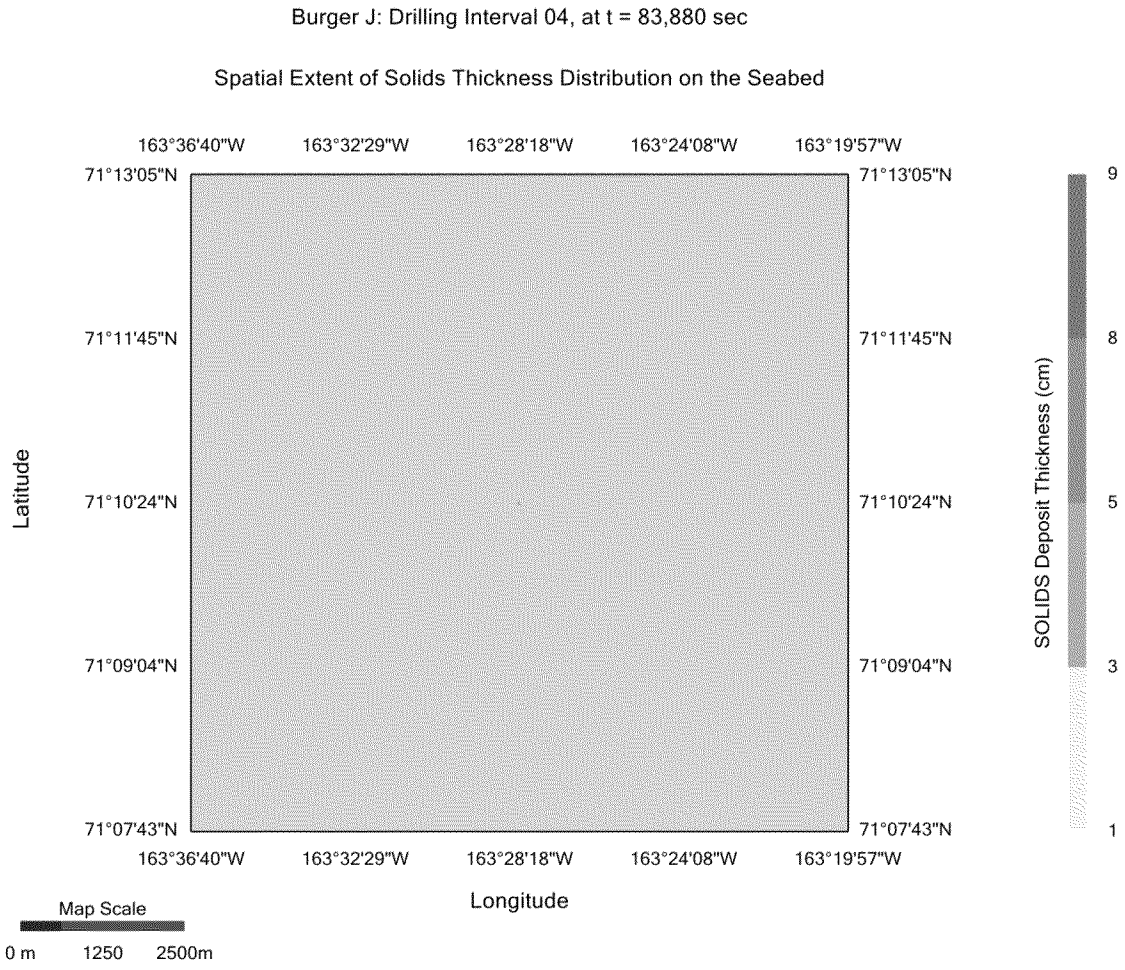
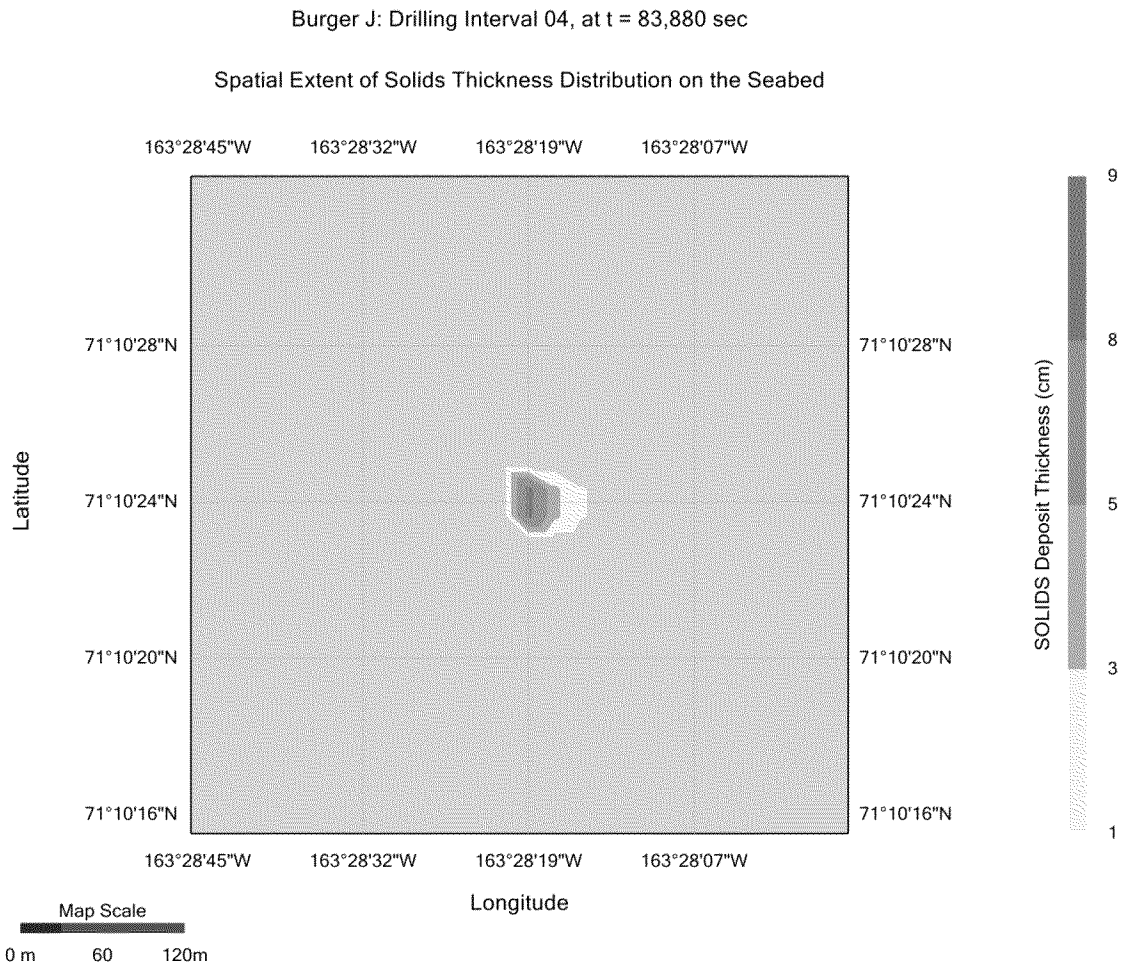


Figure 5-20b: Spatial extent of solids thickness distribution on seabed, Burger J, Drilling Interval 04 (Zoom In View)



5.5 Model Results for Sea Surface Discharge Scenario – Drilling Interval 05

Trajectory and Shape of the Discharge Plume

The trajectory of the discharge plume is presented in **Figure 5-21**. The depth of water is 43.9 m and discharge occurs at a depth of 6.7 m below the sea surface. The heavier plume travels 11.2 m from the source before collapsing into the ambient. The shape and width of the discharge plume is presented in **Figure 5-22**. The width of the plume is approximately 12.35 m at a distance 11.2 m from the source.

Figure 5-21: Trajectory of the discharge plume, Burger J, Drilling Interval 05

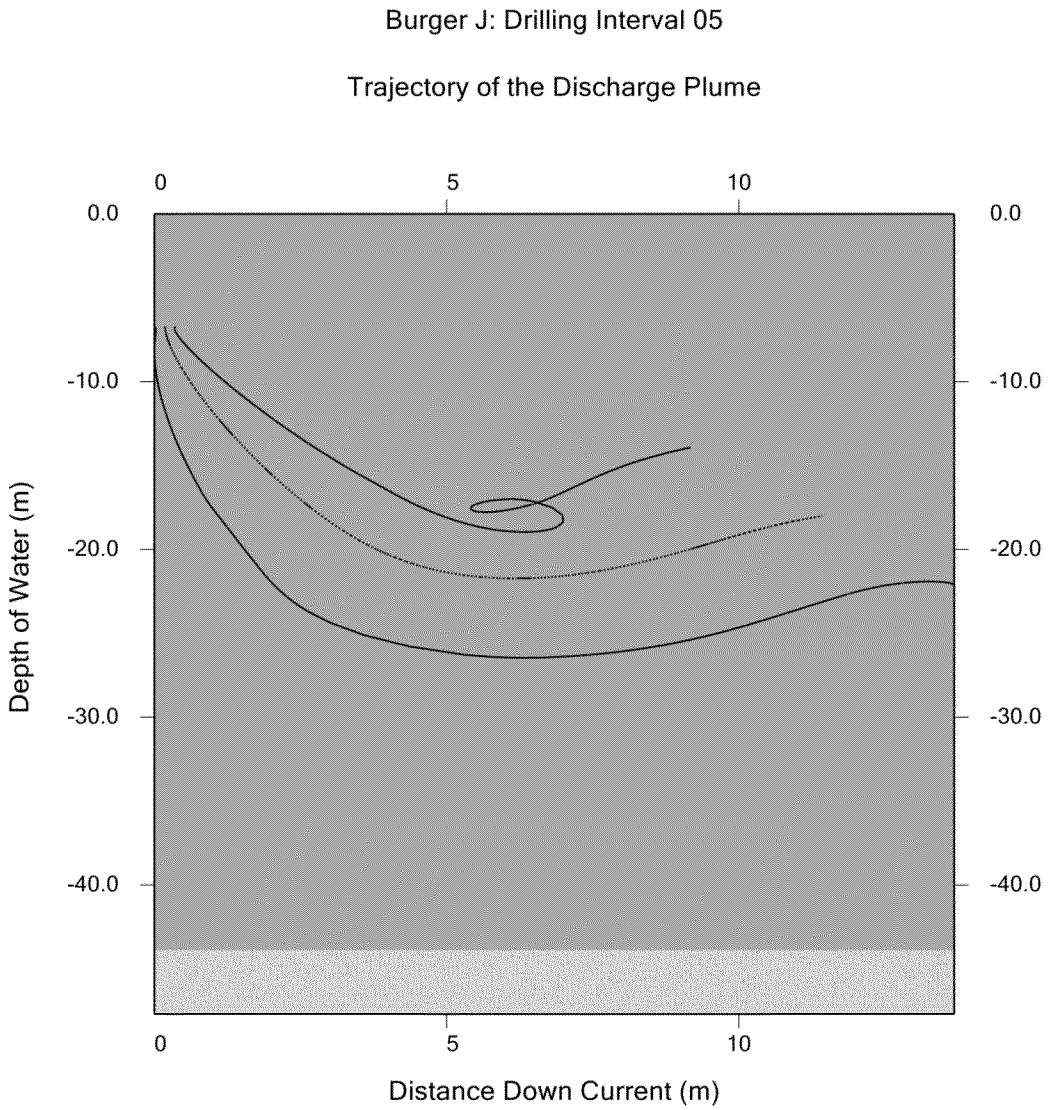
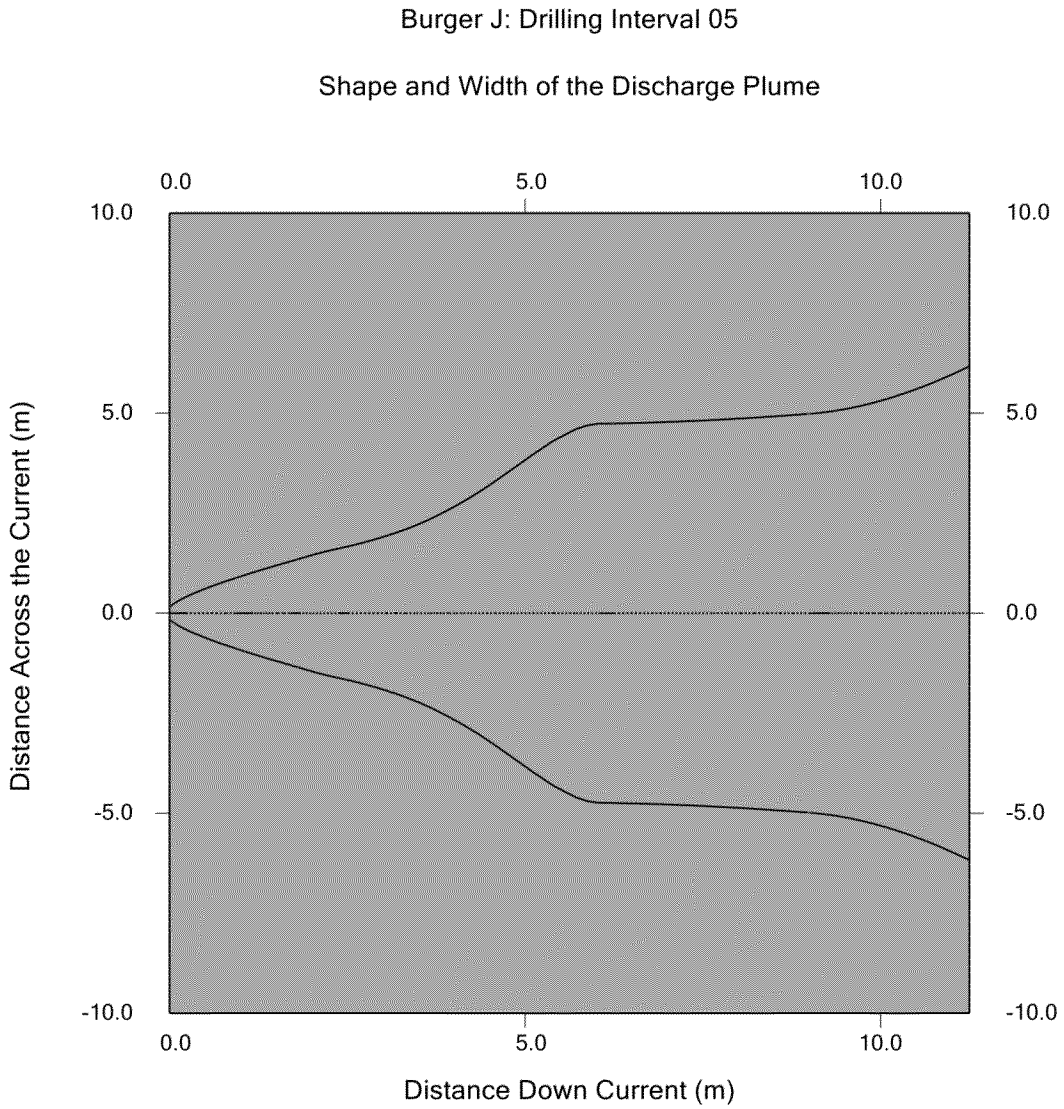


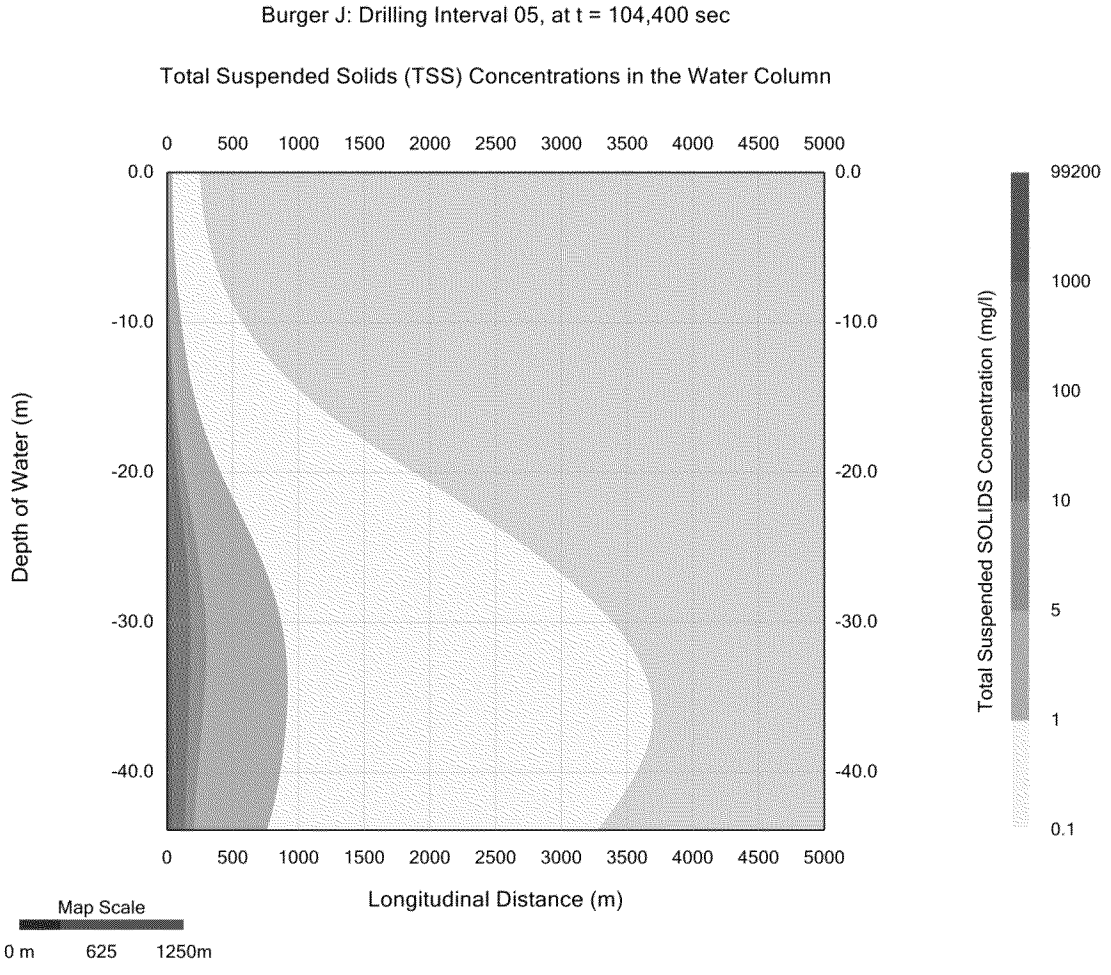
Figure 5-22: Shape and width of the discharge plume, Burger J, Drilling Interval 05



TOTAL SUSPENDED SOLIDS (TSS) CONCENTRATIONS IN THE WATER COLUMN

The total suspended solids (TSS) concentrations in the water column at time, t = 104,400 sec which is the discharge duration for this drilling interval is presented in **Figure 5-23**. The depth of water is 43.9 m at the discharge location. The maximum TSS concentration 99,200 mg/l occurs at the discharge location. It decreases to a value of 10 mg/l at a distance approximately 150 m from the discharge location. The TSS concentration varies from 10 to 5 mg/l between 150 and 300 m distances from the discharge location. The TSS concentration varies from 5 to 1 mg/l between 300 and 900 m distances from the source. The TSS concentration is less than 1.0 mg/l beyond 900 m from the discharge location.

Figure 5-23: Total suspended solids concentrations in water column, Burger J, Drilling Interval 05

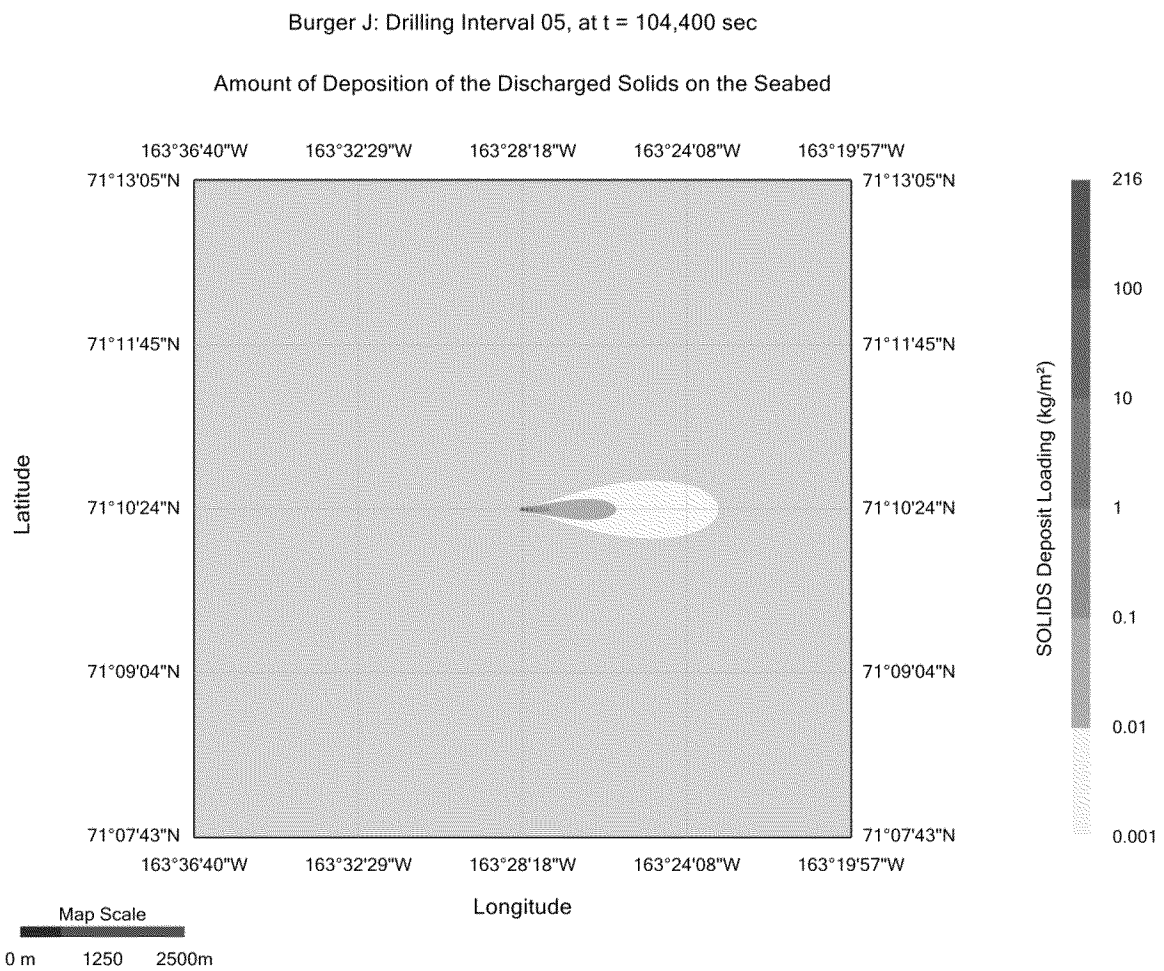


AMOUNT OF DEPOSITION (IN kg/m^2) OF THE DISCHARGED SOLIDS ON THE SEABED

The spatial extent and the amount of solids loading on the sea floor at time, t = 104,400 sec as a result of the discharge of drilling fluids and water based drill cuttings on a plan view is presented in **Figure 5-24**. The model domain extends to 5.0 km in all directions from the discharge location. The map scale is located at the bottom left corner of this figure. The color bar on the right provides the range of the solids loading on the sea floor in kg/m^2 by a particular color band. The maximum loading 216 kg/m^2 occurs at 10.0 m to the east from the discharge location. It decreases to a value of 1 kg/m^2 and 0.1 kg/m^2 at distances approximately 150 m and 250 m, respectively from the discharge location. The loading varies from 0.1 kg/m^2 to 0.01 kg/m^2 approximately between 250 m and 1,400 m distances from the discharge location. The loading is less than 0.01 kg/m^2 beyond 1,400 m from the discharge location.

The sea floor areas affected by solids deposit loading of more than 10-, 1-, 0.1- and 0.01-kg/m^2 are: 0.327, 0.760, 5.146, and 31.839 ha, respectively.

Figure 5-24: Amount of deposition of the solids on the seabed, Burger J, Drilling Interval 05



SPATIAL EXTENT OF SOLIDS THICKNESS DISTRIBUTION ON THE SEABED

The spatial extent of solids thickness of 1 cm or larger deposited on the sea floor at time, t = 104,400 sec as a result of the discharge of drilling fluids and water based drill cuttings on a plan view is presented in **Figures 5-25a** and **5-25b**. The map scale is located at the bottom left corner of these figures. The color bar on the right provides the range of the solids deposit thickness on the sea floor in cm by a particular color band. The model domain extends to 5.0 km in all directions from the discharge location as presented in Figure 5-25a. The solids deposited on the seabed of thickness 1 cm or larger as shown by a small dot, occurs on a very small surface area compare to the 10 km x 10 km map surface area shown in Figure 5-25a. The same results are presented in Figure 5-25b but shows only 480 m x 480 m seabed surface with the well at the center to show the details of the solids accumulation of 1 cm or larger on the seabed. The maximum deposit thickness of 14 cm occurs at 10.0 m to the east from the discharge location. It decreases to a value of 1 cm at a distance approximately 50 m from the discharge location.

The sea floor area affected by solids deposit thickness of 1 cm or larger is approximately a 70 m x 40 m rectangle area (or 0.269 ha to be exact) as presented in Figure 5-25b. The sea floor areas affected by deposit thickness larger than 10- and 1-cm are: 0.098 and 0.269 ha, respectively.

Figure 5-25a: Spatial extent of solids thickness distribution on seabed, Burger J, Drilling Interval 05

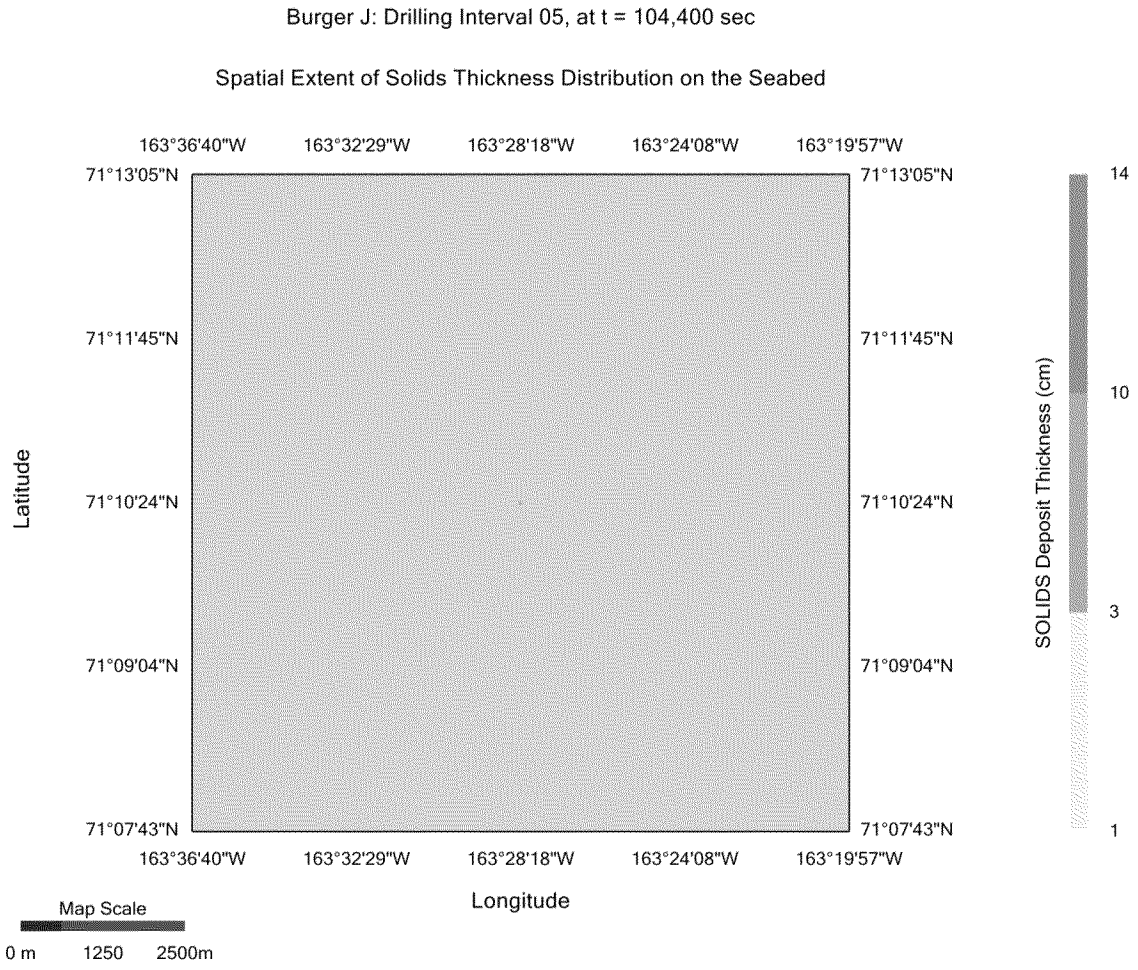
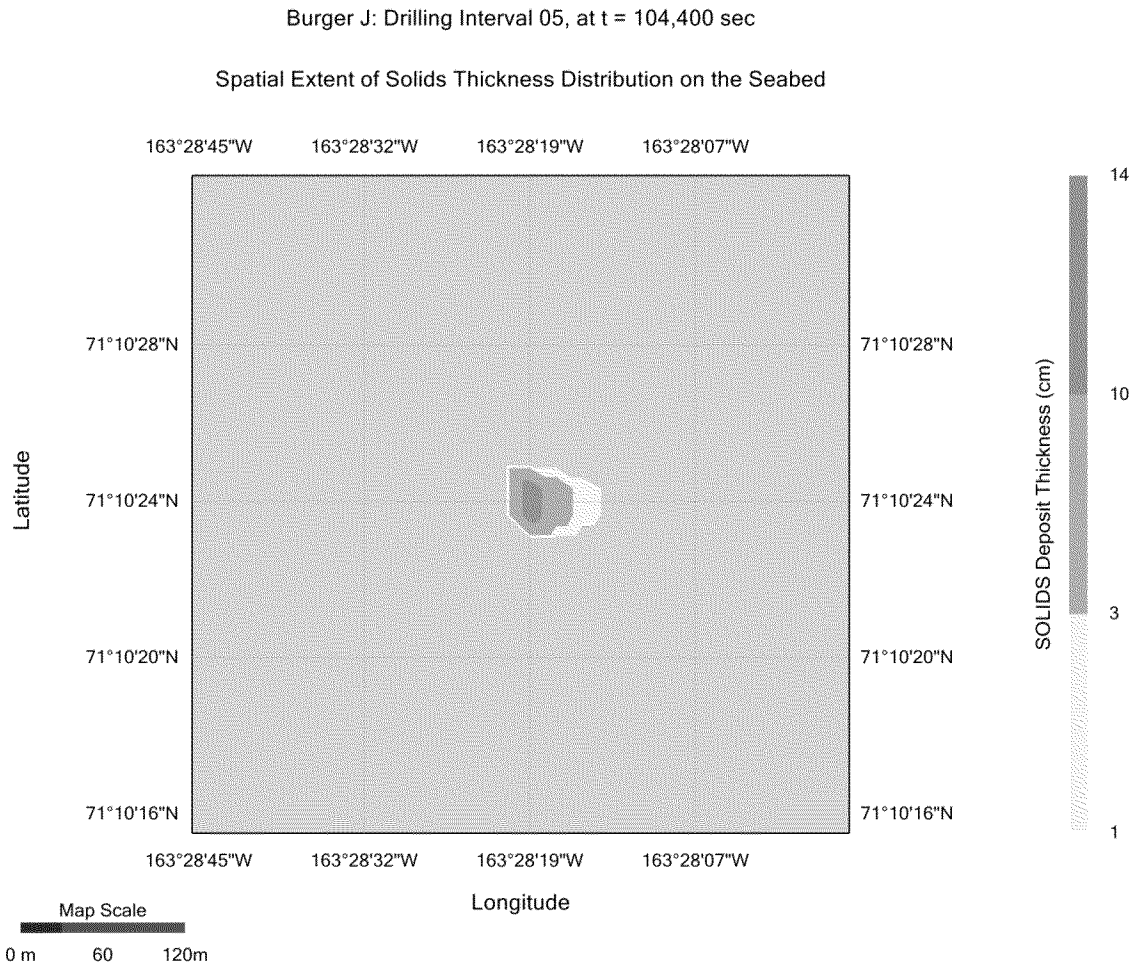


Figure 5-25b: Spatial extent of solids thickness distribution on seabed, Burger J, Drilling Interval 05 (Zoom In View)



5.6 Model Results for Sea Surface Discharge Scenario – Drilling Interval 06

Trajectory and Shape of the Discharge Plume

The trajectory of the discharge plume is presented in **Figure 5-26**. The depth of water is 43.9 m and discharge occurs at a depth of 6.7 m below the sea surface. The heavier plume travels 10.6 m from the source before collapsing into the ambient. The shape and width of the discharge plume is presented in **Figure 5-27**. The width of the plume is approximately 9.3 m at a distance 10.6 m from the source.

Figure 5-26: Trajectory of the discharge plume, Burger J, Drilling Interval 06

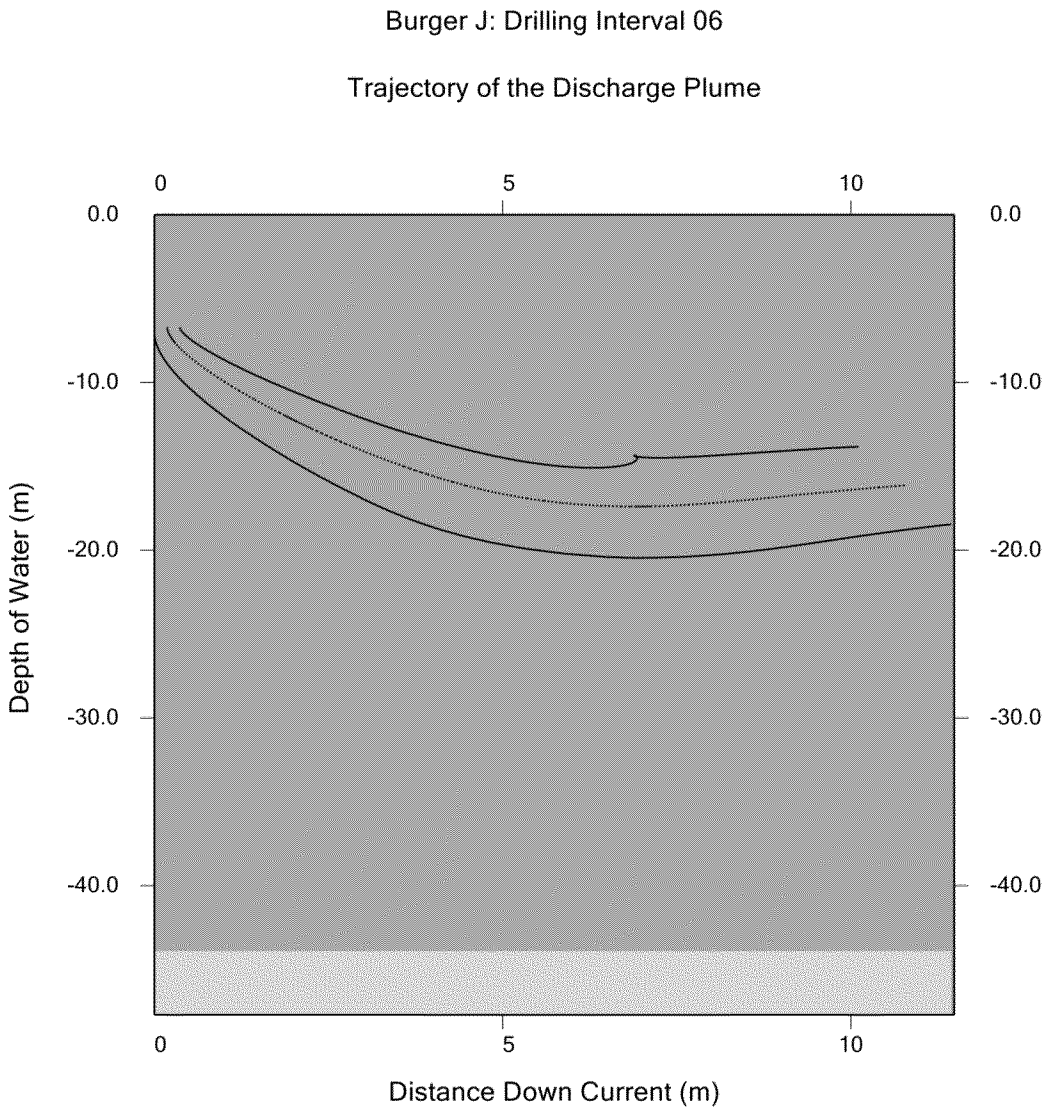
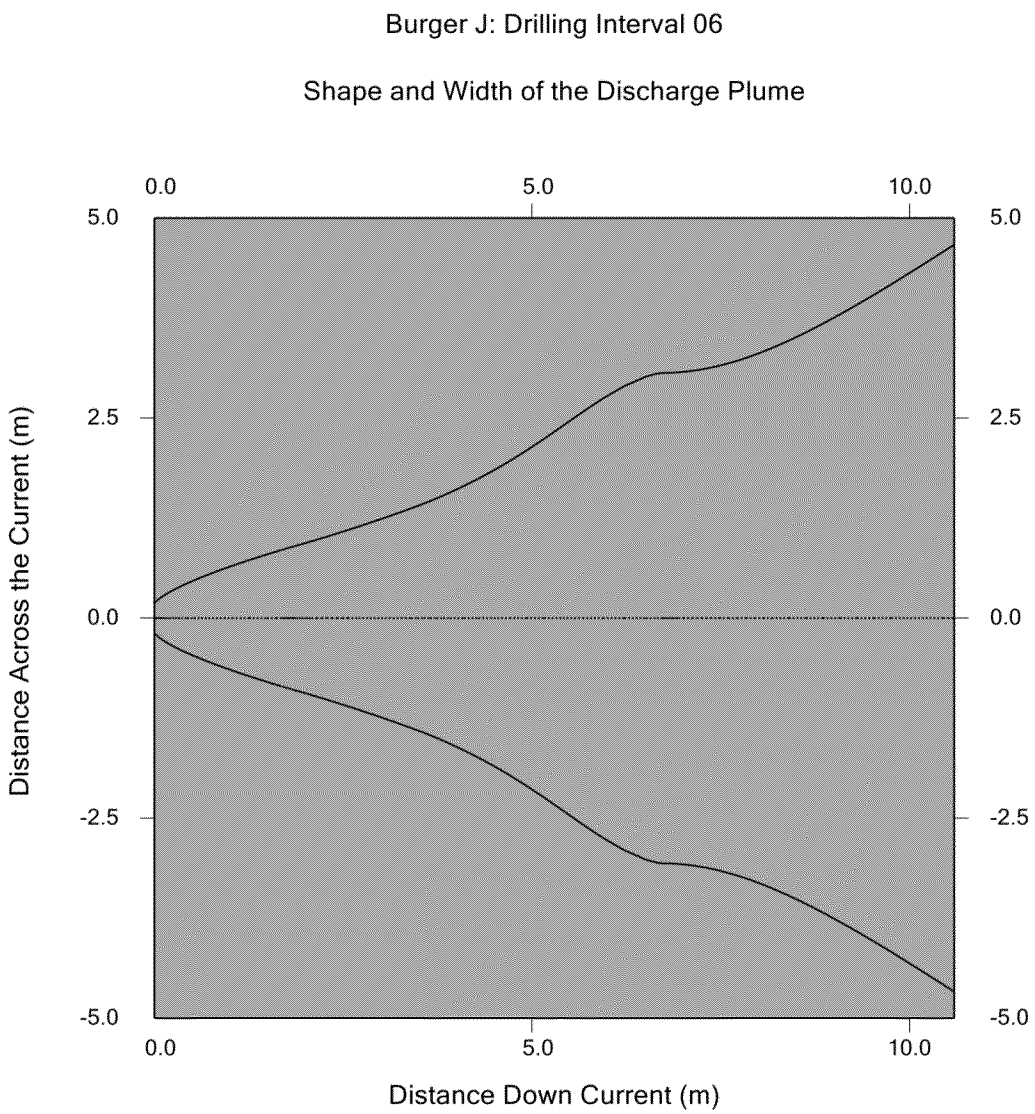


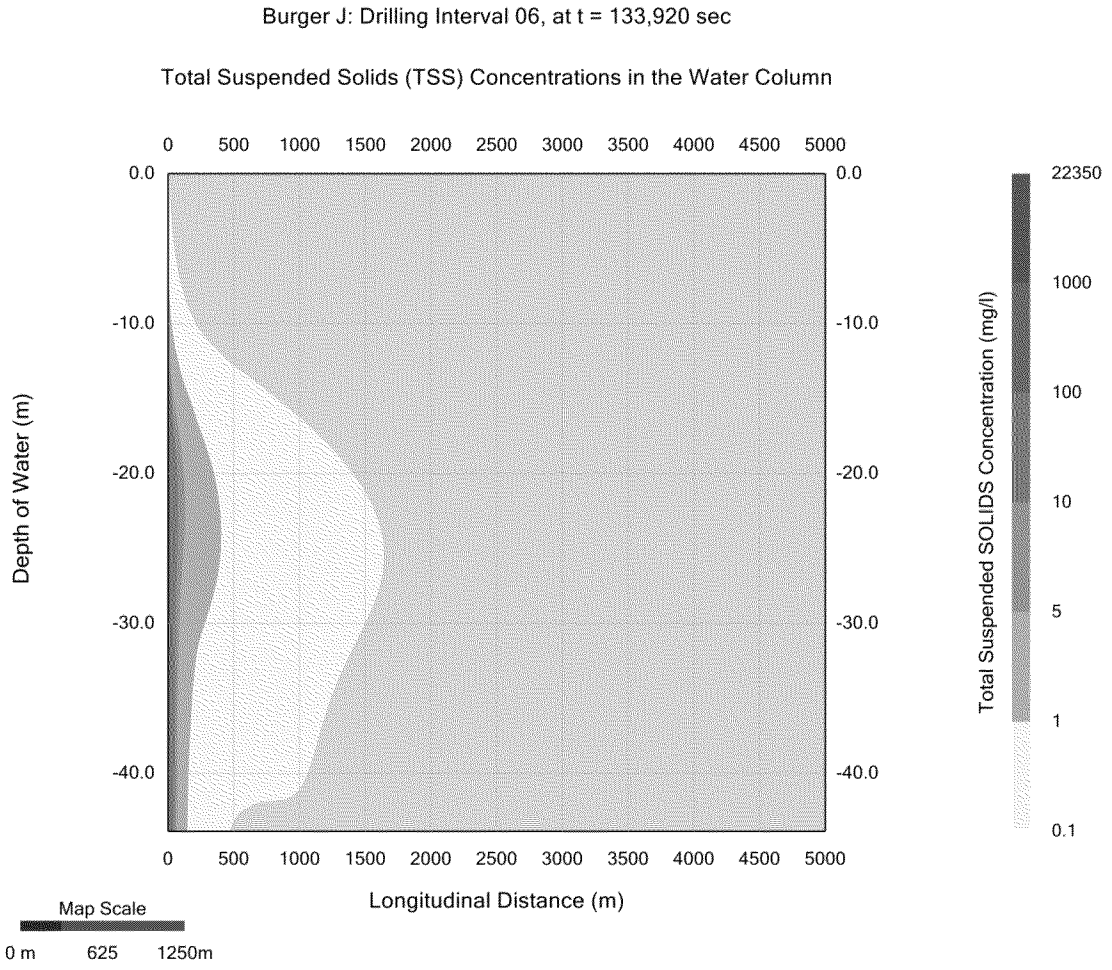
Figure 5-27: Shape and width of the discharge plume, Burger J, Drilling Interval 06



TOTAL SUSPENDED SOLIDS (TSS) CONCENTRATIONS IN THE WATER COLUMN

The total suspended solids (TSS) concentrations in the water column at time, t = 133,920 sec which is the discharge duration for this drilling interval is presented in **Figure 5-28**. . The depth of water is 43.9 m at the discharge location. The maximum TSS concentration 22,350 mg/l occurs at the discharge location. It decreases to a value of 10 mg/l at a distance approximately 75 m from the discharge location. The TSS concentration varies from 10 to 5 mg/l between 75 m and 150 m distances from the discharge location. The TSS concentration varies from 5 to 1 mg/l between 150 m and 425 m distances from the source. The TSS concentration is less than 1.0 mg/l beyond 425 m from the discharge location.

Figure 5-28: Total suspended solids concentrations in water column, Burger J, Drilling Interval 06

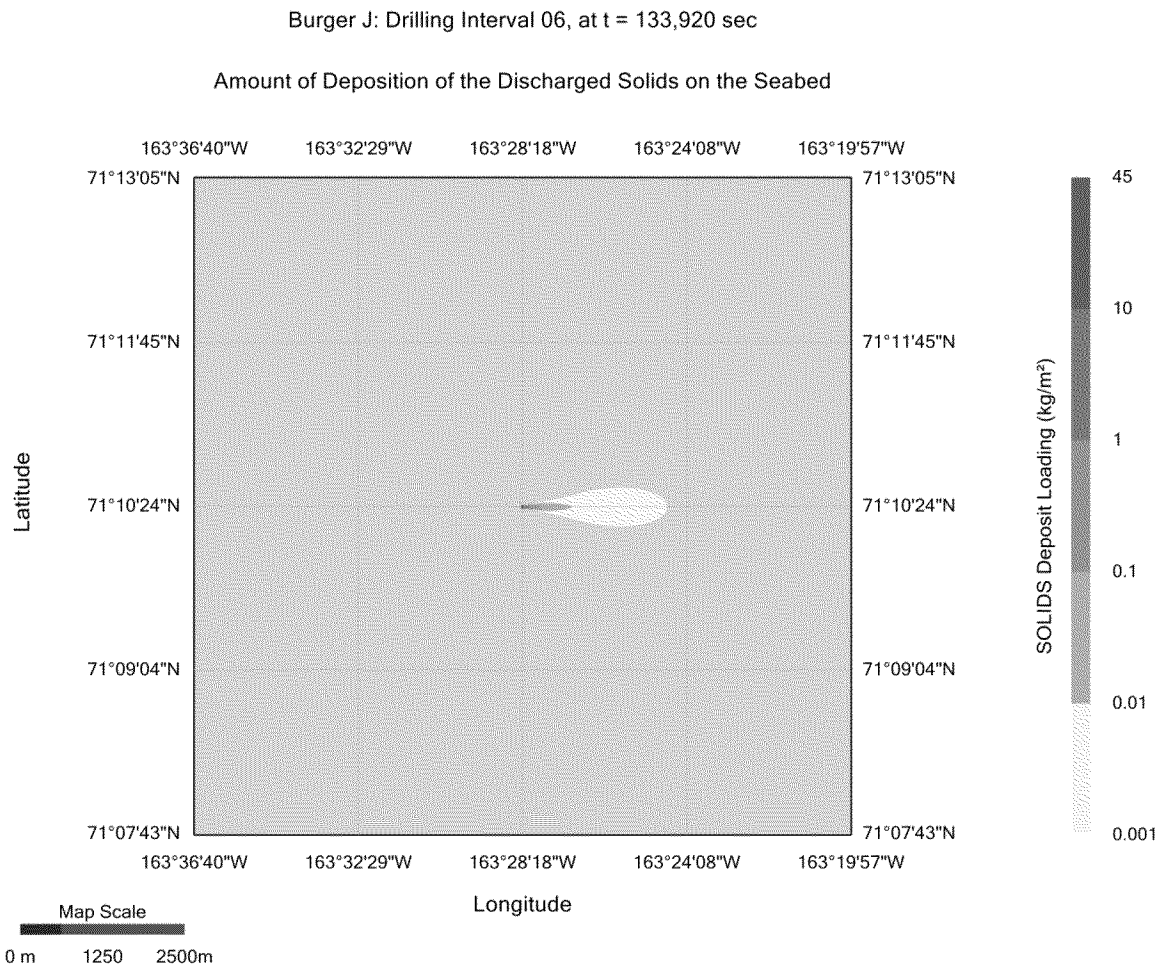


AMOUNT OF DEPOSITION (IN kg/m^2) OF THE DISCHARGED SOLIDS ON THE SEABED

The spatial extent and the amount of solids loading on the sea floor at time, t = 133,920 sec as a result of the discharge of drilling fluids and water based drill cuttings on a plan view is presented in **Figure 5-29**. The model domain extends to 5.0 km in all directions from the discharge location. The map scale is located at the bottom left corner of this figure. The color bar on the right provides the range of the solids loading on the sea floor in kg/m^2 by a particular color band. The maximum loading 45 kg/m^2 occurs at 10.0 m to the east from the discharge location. It decreases to a value of 1 kg/m^2 and 0.1 kg/m^2 at distances approximately 150 m and 300 m, respectively from the discharge location. The loading varies from 0.1 kg/m^2 to 0.01 kg/m^2 approximately between 300 m and 800 m distances from the discharge location. The loading is less than 0.01 kg/m^2 beyond 800 m from the discharge location.

The sea floor areas affected by solids deposit loading of more than 10-, 1-, 0.1- and 0.01-kg/m^2 are: 0.195, 0.509, 1.201, and 7.432 ha, respectively.

Figure 5-29: Amount of deposition of the solids on the seabed, Burger J, Drilling Interval 06



SPATIAL EXTENT OF SOLIDS THICKNESS DISTRIBUTION ON THE SEABED

The spatial extent of solids thickness of 1 cm or larger deposited on the sea floor at time, t = 133,920 sec as a result of the discharge of drilling fluids and water based drill cuttings on a plan view is presented in **Figures 5-30a** and **5-30b**. The map scale is located at the bottom left corner of these figures. The color bar on the right provides the range of the solids deposit thickness on the sea floor in cm by a particular color band. The model domain extends to 5.0 km in all directions from the discharge location as presented in Figure 5-30a. The solids deposited on the seabed of thickness 1 cm or larger as shown by a small dot, occurs on a very small surface area compare to the 10 km x 10 km map surface area shown in Figure 5-30a. The same results are presented in Figure 5-30b but shows only 480 m x 480 m seabed surface with the well at the center to show the details of the solids accumulation of 1 cm or larger on the seabed. The maximum deposit thickness of 2.9 cm occurs at 10.0 m to the east from the discharge location. It decreases to a value of 1 cm at a distance approximately 30 m from the discharge location.

The sea floor area affected by solids deposit thickness of 1 cm or larger is approximately a 45 m x 40 m rectangle area (or 0.180 ha to be exact) as presented in Figure 5-30b. The sea floor areas affected by deposit thickness larger than 2- and 1-cm are: 0.06 and 0.180 ha, respectively.

Figure 5-30a: Spatial extent of solids thickness distribution on seabed, Burger J, Drilling Interval 06

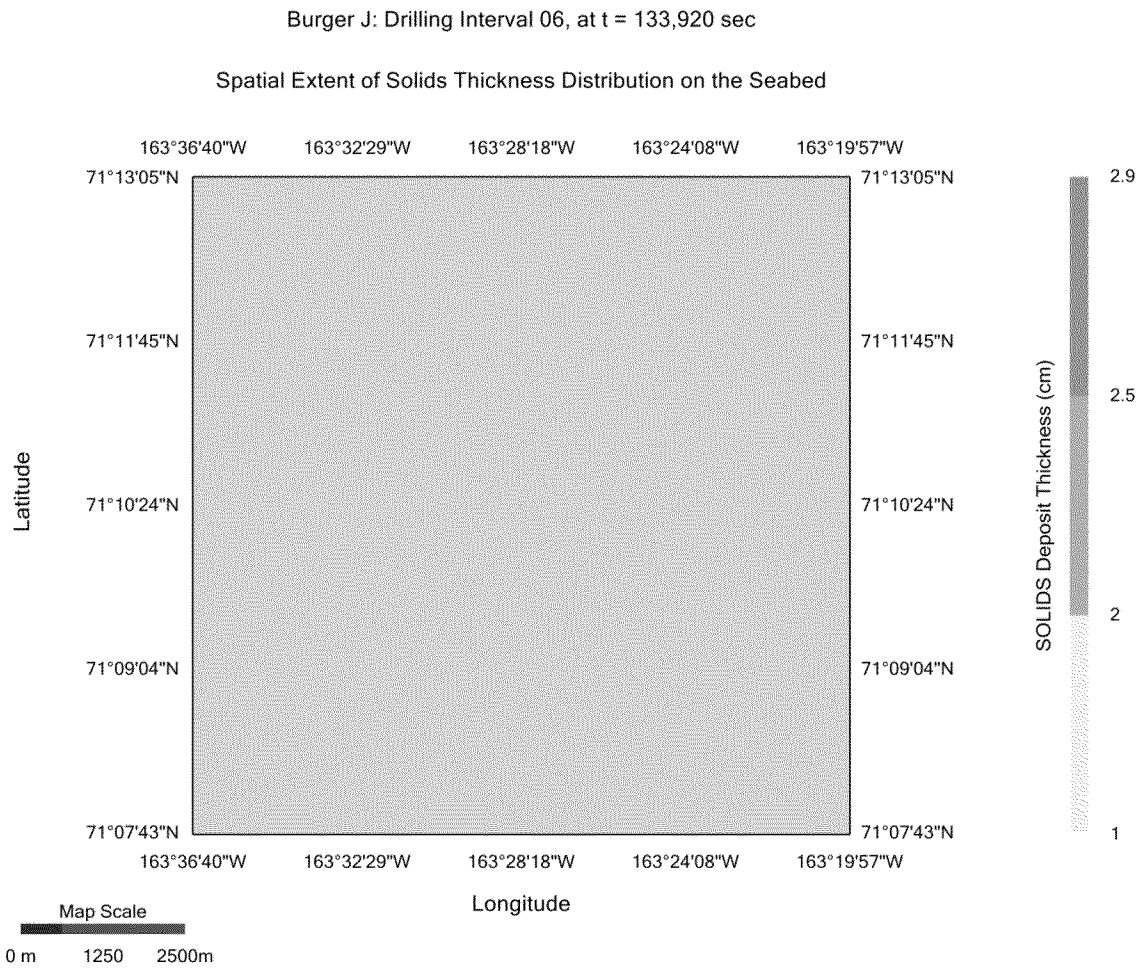
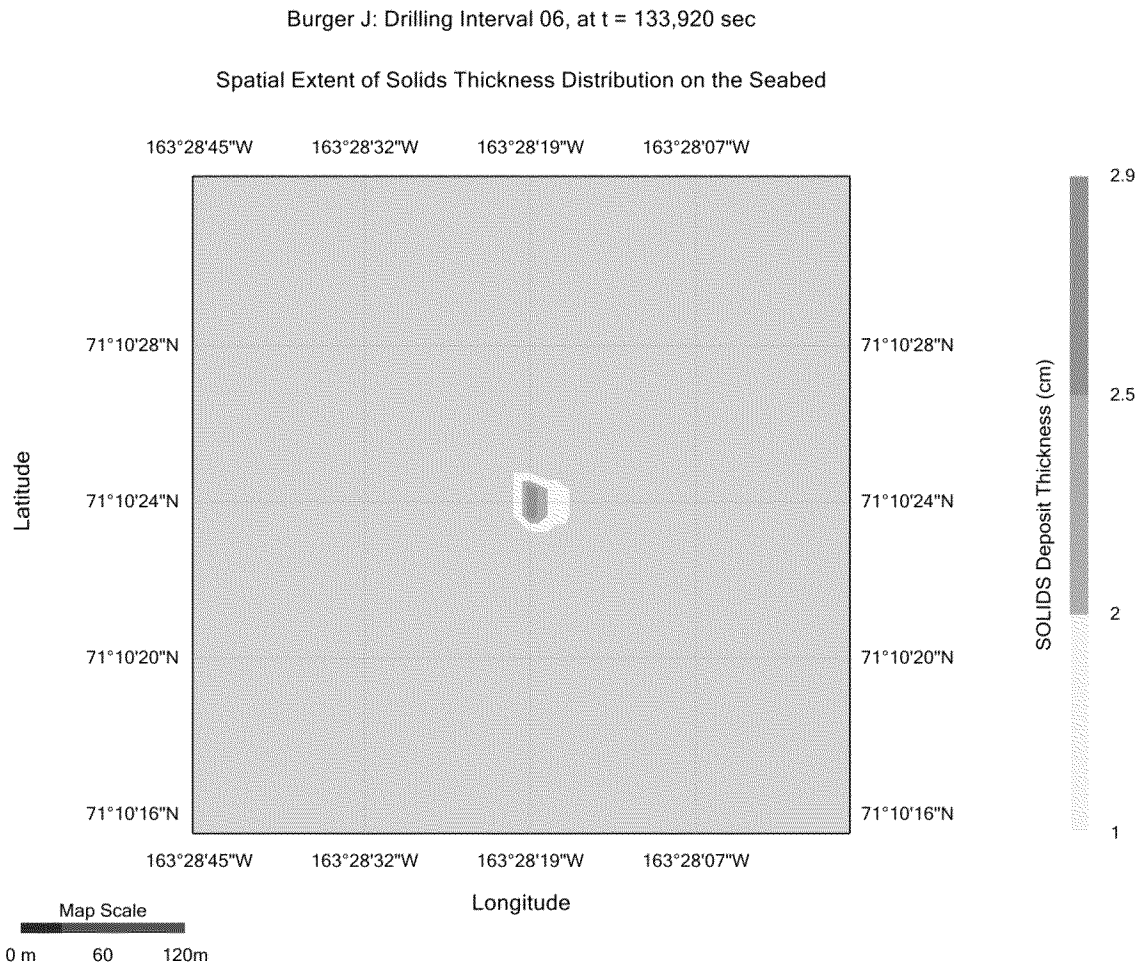


Figure 5-30b: Spatial extent of solids thickness distribution on seabed, Burger J, Drilling Interval 06 (Zoom In View)



5.7 Model Results for Sea Surface Discharge Scenario – Drilling Fluids Discharge from Rigs Surface Pits at The end of Drilling Operation

Trajectory and Shape of the Discharge Plume

The trajectory of the discharge plume is presented in **Figure 5-31**. The depth of water is 43.9 m and discharge occurs at a depth of 6.7 m below the sea surface. The heavier plume travels approximately 29.0 m from the source before collapsing into the ambient. The shape and width of the discharge plume is presented in **Figure 5-32**. The width of the plume is 76.3 m at a distance 29.0 m from the source.

Figure 5-31: Trajectory of the discharge plume, Burger J, Rig's Surface Pits

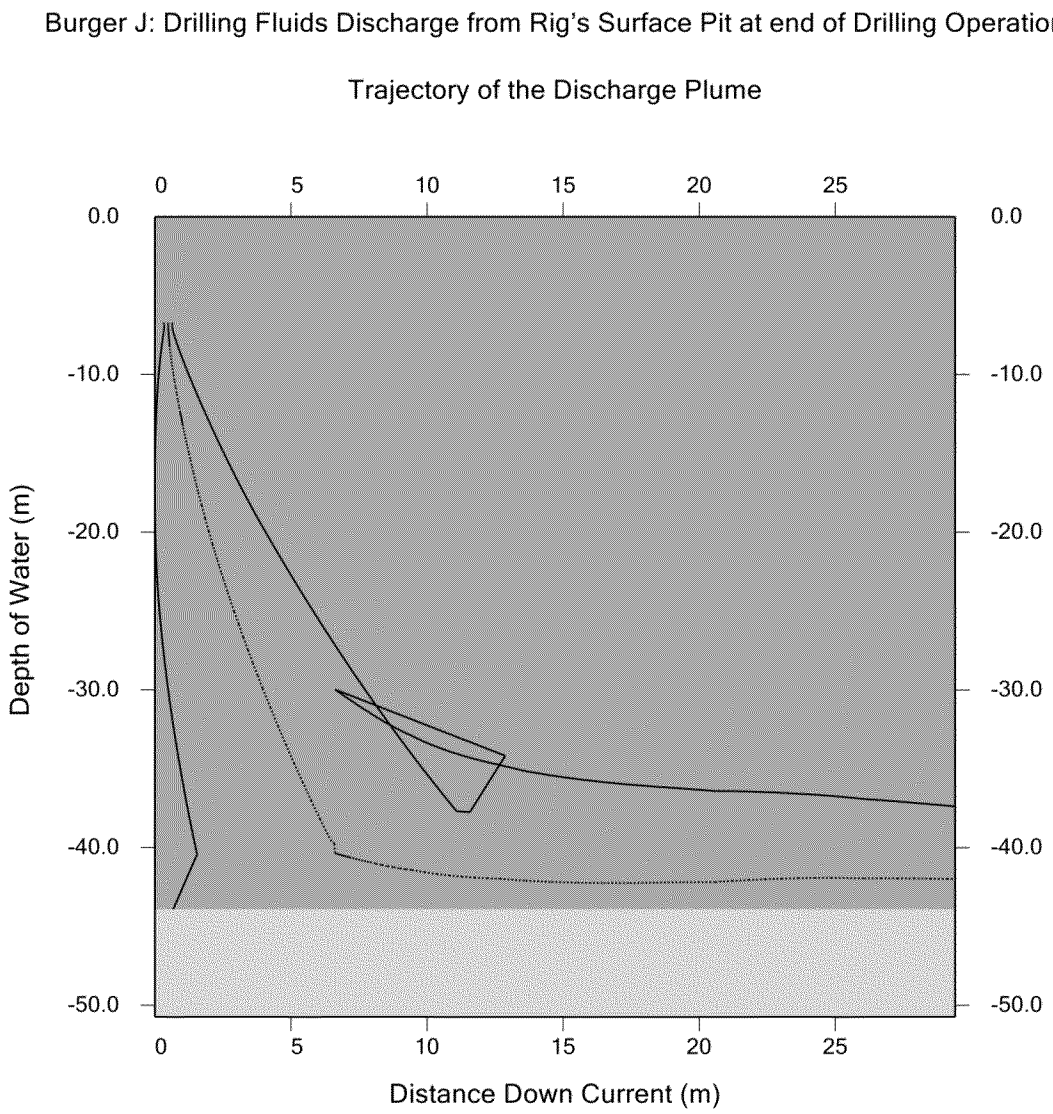
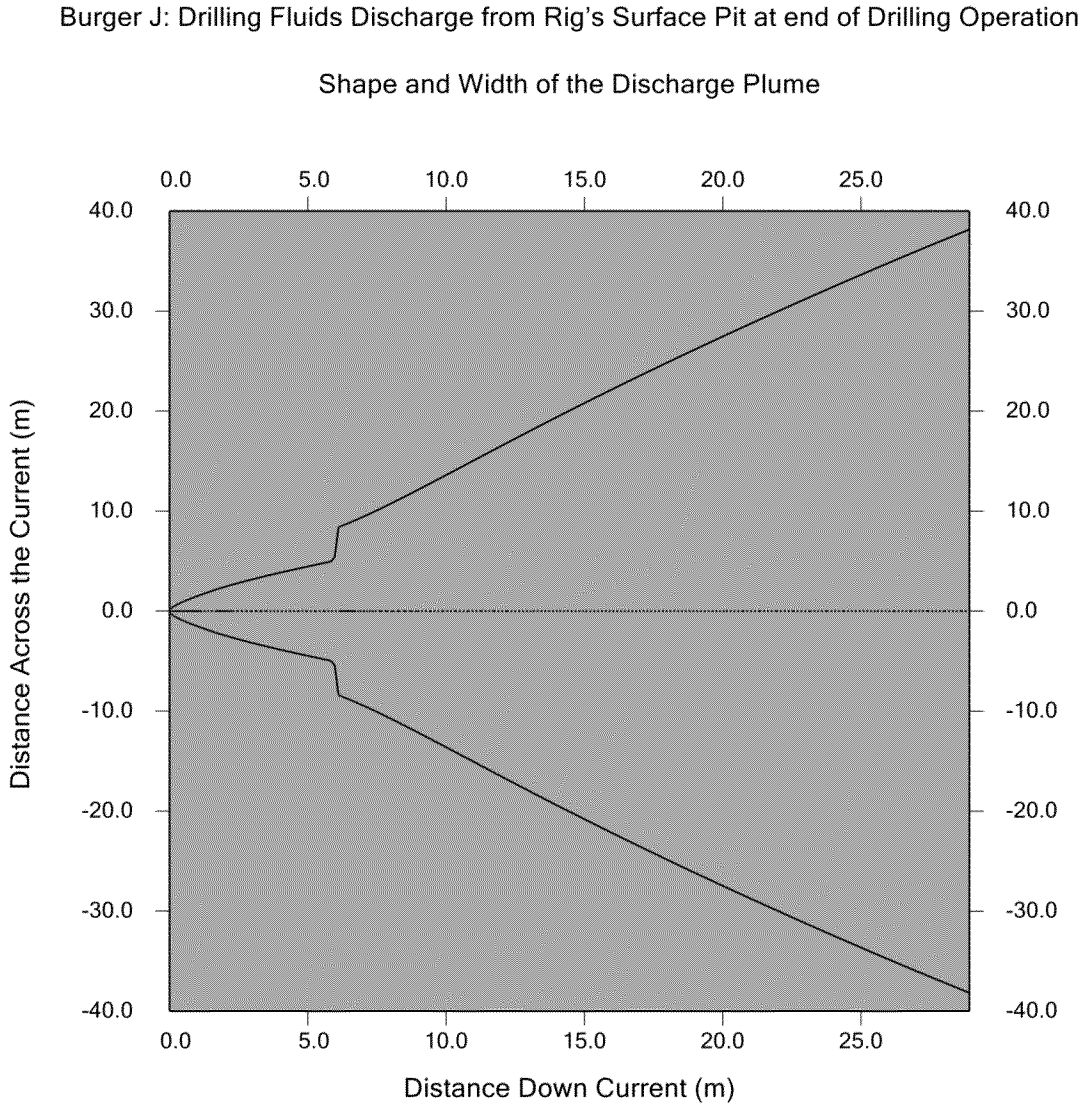


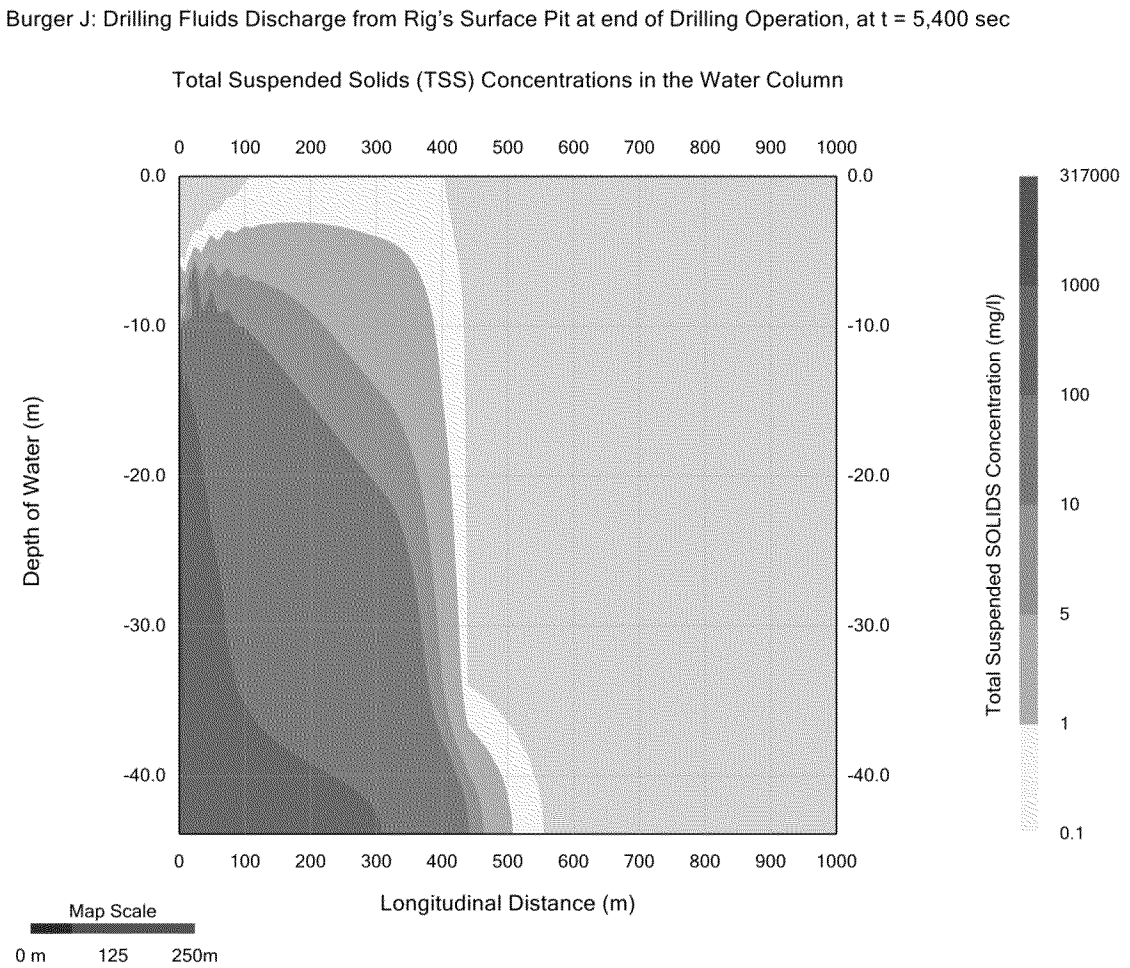
Figure 5-32: Shape and width of the discharge plume, Burger J, Rig's Surface Pits



TOTAL SUSPENDED SOLIDS (TSS) CONCENTRATIONS IN THE WATER COLUMN

The total suspended solids (TSS) concentration in the water column at time, t = 5,400 sec which is the discharge duration for the drilling fluids from the rig's surface pits is presented in **Figure 5-33**. The depth of water is 43.9 m at the discharge location. The maximum TSS concentration 317,000 mg/l occurs at the discharge location. It decreases rapidly to a value of 100 mg/l at a distance approximately 300 m from the discharge location. The TSS concentration varies from 100 to 10 mg/l between 300 m and 440 m distances from the discharge location. The TSS concentration varies from 10 to 5 mg/l between 440 m and 470 m distances from the source. The TSS concentration varies from 5 to 1 mg/l between 470 m and 500 m distances from the source. The TSS concentration is less than 1.0 mg/l beyond 500 m from the discharge location.

Figure 5-33: Total suspended solids concentrations in water column, Burger J, Rig's Surface Pits

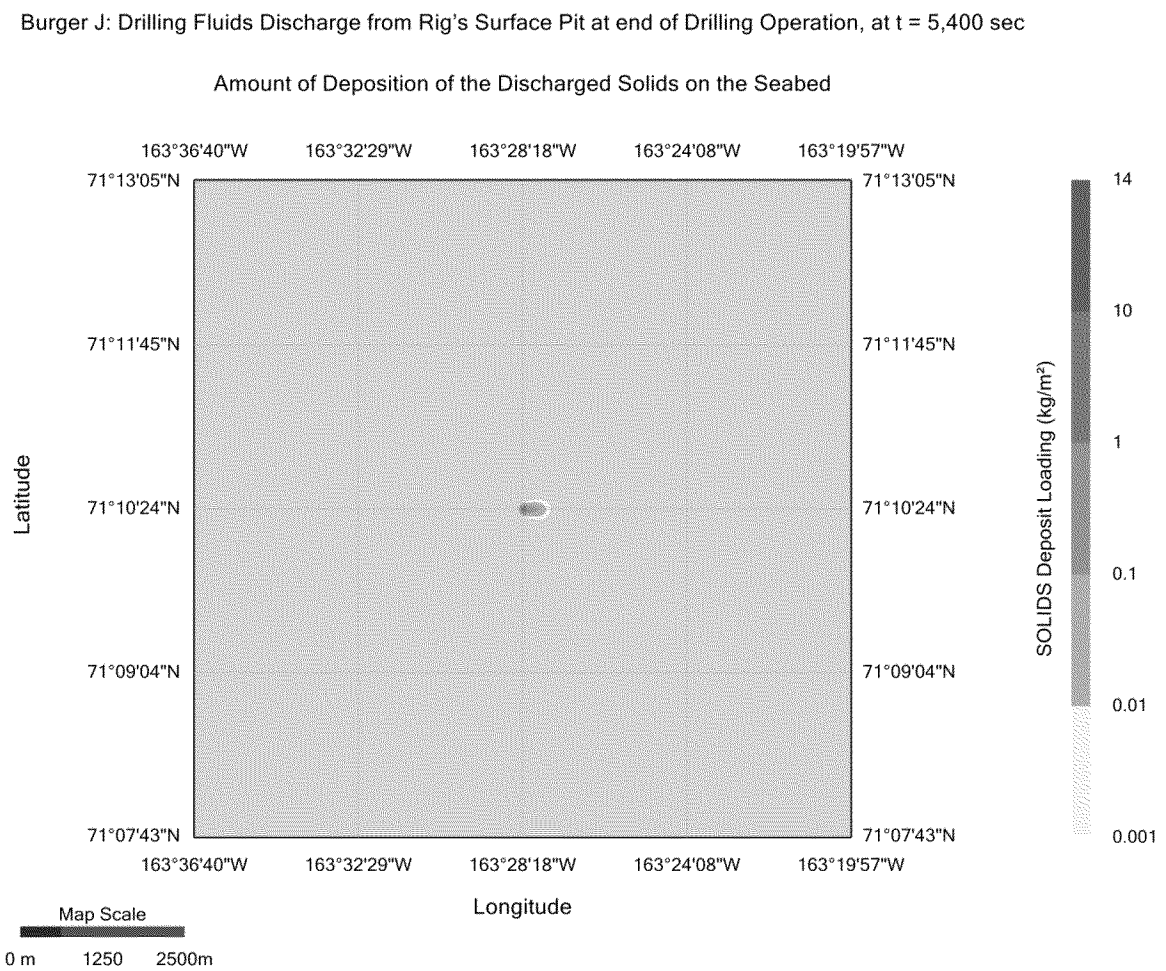


AMOUNT OF DEPOSITION (IN kg/m^2) OF THE DISCHARGED SOLIDS ON THE SEABED

The spatial extent and the amount of solids loading on the sea floor at time, t = 5,400 sec as a result of the discharge of drilling fluids from the rig's surface pits on a plan view is presented in **Figure 5-34**. The model domain extends to 5.0 km in all directions from the discharge location. The map scale is located at the bottom left corner of this figure. The color bar on the right provides the range of the solids loading on the sea floor in kg/m^2 by a particular color band. The maximum loading 14 kg/m^2 occurs at 30.0 m to the east from the discharge location. It decreases to a value of 1 kg/m^2 and 0.1 kg/m^2 at distances approximately 50 m and 250 m, respectively from the discharge location. The loading varies from 0.1 kg/m^2 to 0.01 kg/m^2 approximately between 250 m and 310 m distances from the discharge location. The loading is less than 0.01 kg/m^2 beyond 310 m from the source.

The sea floor areas affected by solids deposit loading of more than 10-, 1-, 0.1- and 0.01-kg/m^2 are: 0.115, 0.804, 2.898, and 7.594 ha, respectively.

Figure 5-34: Amount of deposition of the solids on the seabed, Burger J, Rig's Surface Pits



SPATIAL EXTENT OF SOLIDS THICKNESS DISTRIBUTION ON THE SEABED

The spatial extent of solids thickness deposited on the sea floor at time, t = 5,400 sec as a result of the discharge of drilling fluids from the rig's surface pits on a plan view is presented in **Figures 5-35a** and **5-35b**. The map scale is located at the bottom left corner of these figures. The color bar on the right provides the range of the solids deposit thickness on the sea floor in cm by a particular color band. The model domain extends to 5.0 km in all directions from the discharge location as presented in Figure 5-35a. **The maximum deposit thickness is less than 1.0 cm**. The solids deposited on the seabed of thickness 0.01 cm or larger as shown by a small dot, occurs on a very small surface area compare to the 10 km x 10 km map surface area shown in Figure 5-35a. The same results are presented in Figure 5-35b but shows only 480 m x 480 m seabed surface with the well at the center to show the details of the solids accumulation of 0.1 cm (i.e., 1 mm) or larger on the seabed. The maximum deposit thickness of 0.67 cm occurs at 30.0 m to the east from the discharge location. The sea floor area affected by solids deposit thickness of 1 mm or larger is approximately a 65 m x 65 m rectangle area (or 0.438 ha to be exact) as presented in Figure 5-35b.

Figure 5-35a: Spatial extent of solids thickness distribution on seabed, Burger J, Rig's Surface Pits

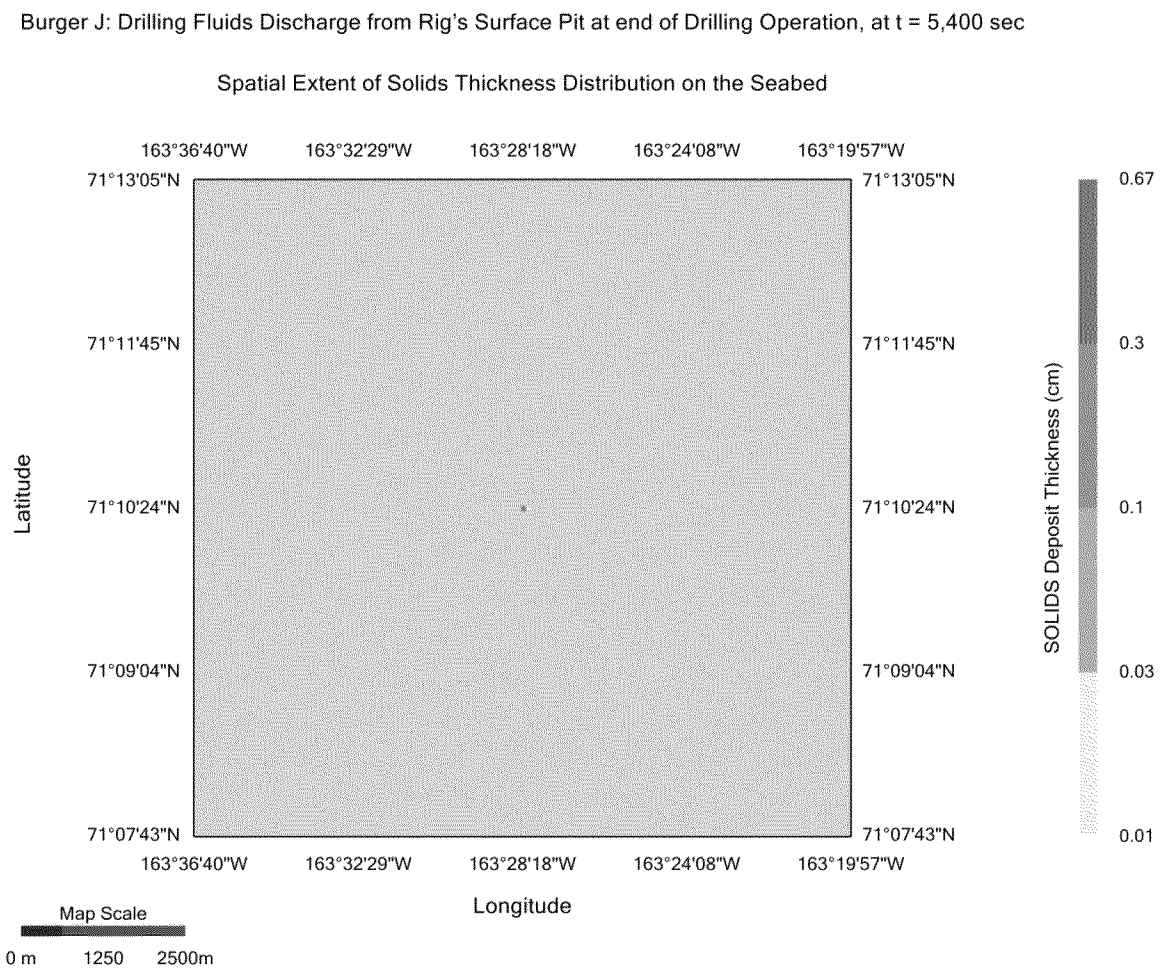
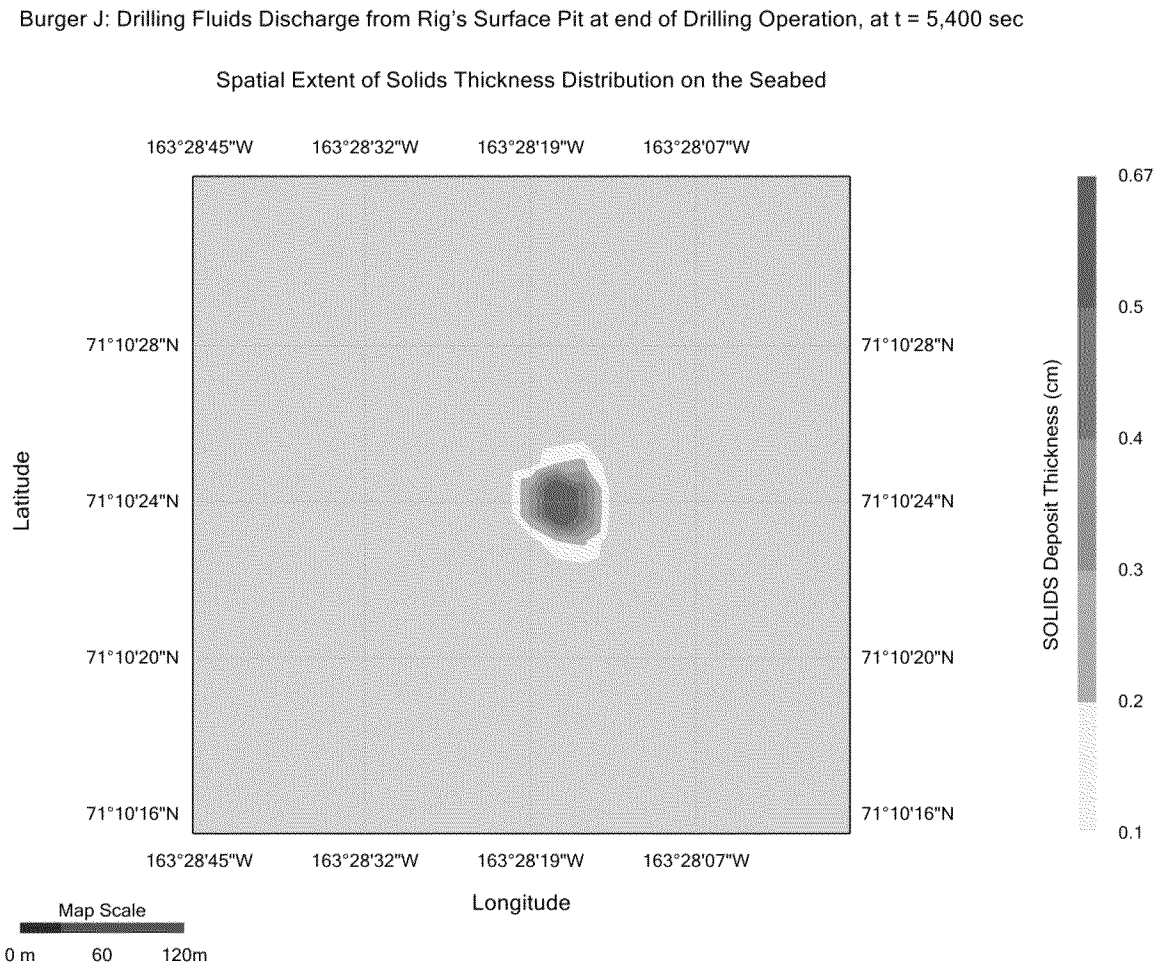


Figure 5-35b: Spatial extent of solids thickness distribution on seabed, Burger J, Rig's Surface Pits (Zoom In View)



5.8 Combined Model Results - Sea Floor and Sea Surface Discharges , Burger J

The spatial extent of total amount of deposition of the discharged solids on the seabed from the six discrete drilling intervals (01, 02, 03, 04, 05, and 06) and the rig's surface pits were compiled using the GUIDO 7 for the OOC model yielding the total solids deposition loading and thickness distribution on the seabed from the drilling operation at the Burger J well site.

Total Amount of Deposition (in kg/m^2) of the Discharged Solids on the Seabed

The spatial extent of the total amount of solids loading at time t = 196.8 hours as a result of the discharge of cement, drilling fluids, and water based drill cuttings on a plan view is presented in **Figures 5-36a** and **5-36b**. The model domain extends to 5.0 km in all directions from the discharge location. The map scale is located at the bottom left corner of this figure. The color bar on the right provides the range of the solids loading on the sea floor in kg/m^2 by a particular color band. The maximum loading 2,861 kg/m^2 occurs at 2.0 m north from the discharge location. It decreases to a value of 1 kg/m^2 and 0.1 kg/m^2 at distances approximately 350 m and 1,100 m, respectively from the discharge location. The loading varies from 0.1 kg/m^2 to 0.01 kg/m^2 approximately between 1,100 m and 2,650 m distances from the discharge location. The loading is less than 0.01 kg/m^2 beyond 2,650 m from the discharge location.

The sea floor areas affected by solids deposit loading of more than 1000-, 100-, 10-, 1-, 0.1-, 0.01- and 0.001-kg/m^2 are: 0.108, 0.264, 0.594, 3.663, 18.610, 130.974, and 729.182 ha, respectively.

The prevailing current direction is to the East. Therefore, the fate and transport of the discharge plume is towards the East only from the source location. Figure 5-36b presents the model domain which extends to 5.0 km to East only from the source. This figure presents the same results as Figure 5-36a but provides a larger view to enhance readability.

Figure 5-36a: Total amount of deposition of the solids on the seabed, Burger J, Intervals 01-06 and Rig's Surface Pits

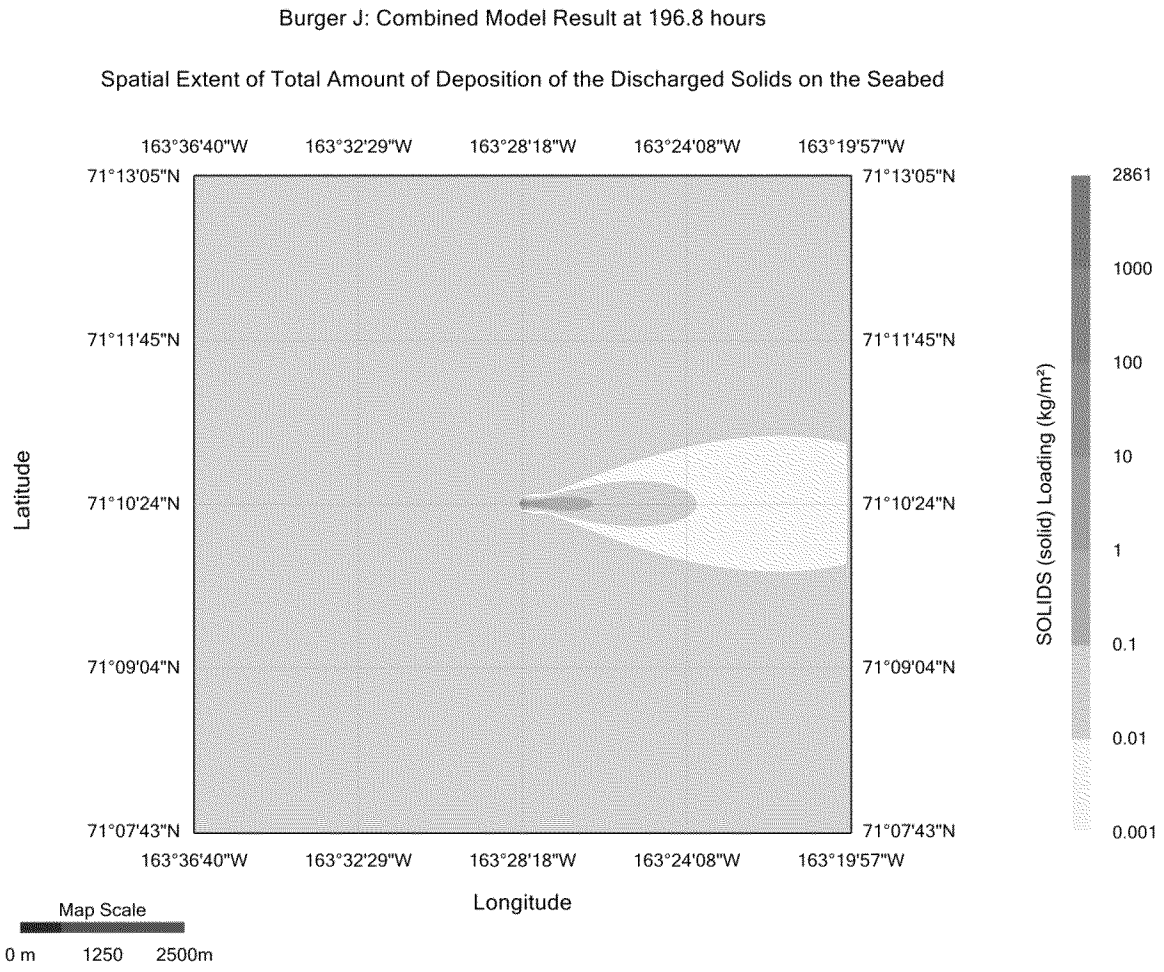
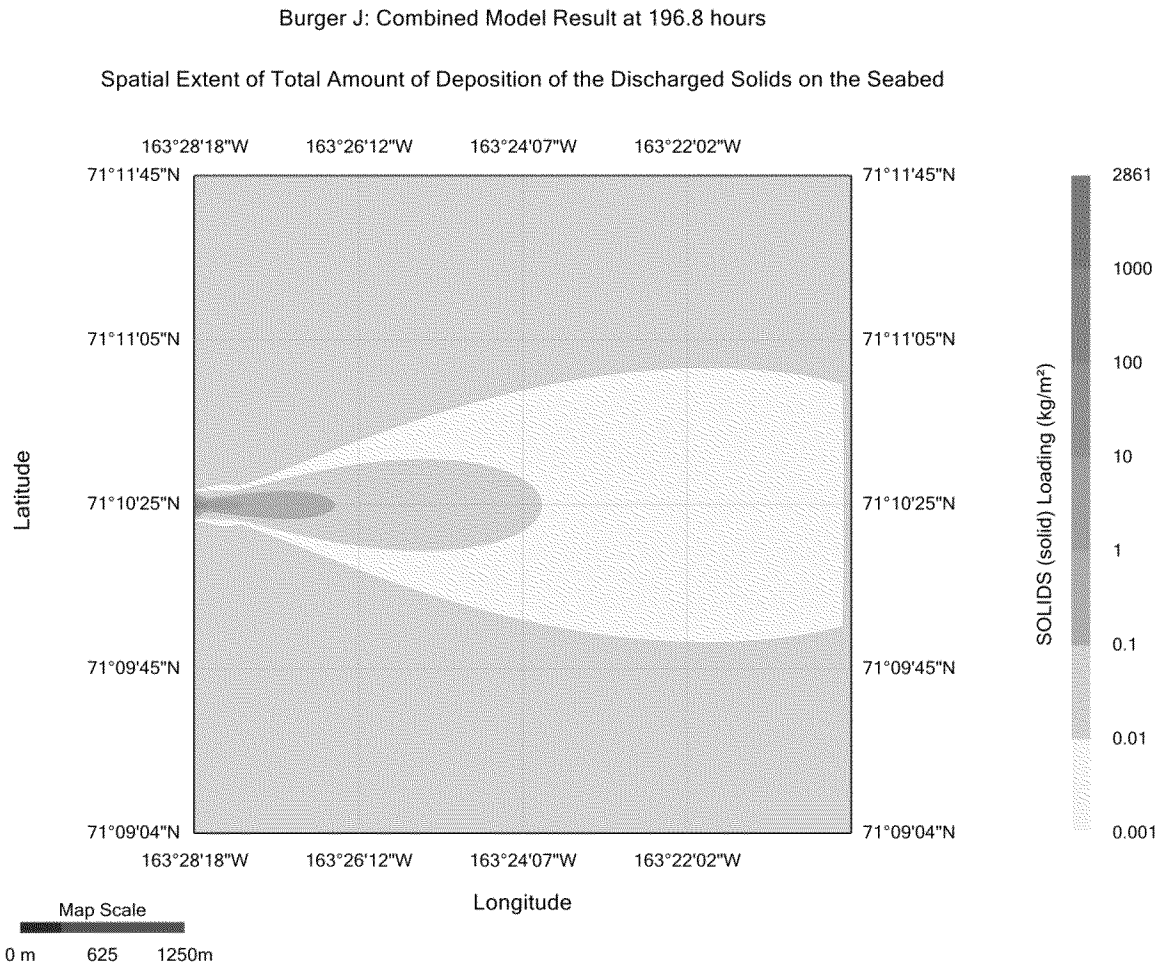


Figure 5-36b: Total amount of deposition of the solids on the seabed, Burger J, Intervals 01-06 and Rig's Surface Pits, larger view



SPATIAL EXTENT OF SOLIDS THICKNESS DISTRIBUTION ON THE SEABED

The spatial extent of the total solids thickness of 1 cm or larger deposited on the sea floor at time t = 196.8 hours as a result of the discharge of cement, drilling fluids, and water based drill cuttings on a plan view is presented in **Figures 5-37a** and **5-37b**. The map scale is located at the bottom left corner of these figures. The color bar on the right provides the range of the solids deposit thickness on the sea floor in cm by a particular color band. The model domain extends to 5.0 km in all directions from the discharge location as presented in Figure 5-37a. The solids deposited on the seabed of thickness 1 cm or larger as shown by a small dot, occurs on a very small surface area compare to the 10 km x 10 km map surface area shown in Figure 5-37a. The same results are presented in Figure 5-37b but shows only 480 m x 480 m seabed surface with the well at the center to show the details of the solids accumulation of 1 cm or larger on the seabed. The maximum deposit thickness of 207 cm occurs at 2.0 m north from the discharge location. It decreases to a value of 1 cm at a distance approximately 100 m to the east from the discharge location.

The sea floor area affected by solids deposit thickness of 1 cm or larger is approximately a 120 m x 40 m rectangle area (or 0.512 ha to be exact) as presented in Figure 5-37b. The sea floor areas affected by deposit thickness larger than 200-, 100-, 10-, and 1-cm are: 0.081, 0.102, 0.196, and 0.512 ha, respectively. The sea floor areas affected by solids deposit thickness is also presented graphically in **Figure 5-38**.

Figure 5-37a: Spatial extent of total solids thickness distribution on seabed, Burger J, Intervals 01-06 and Rig's Surface Pits

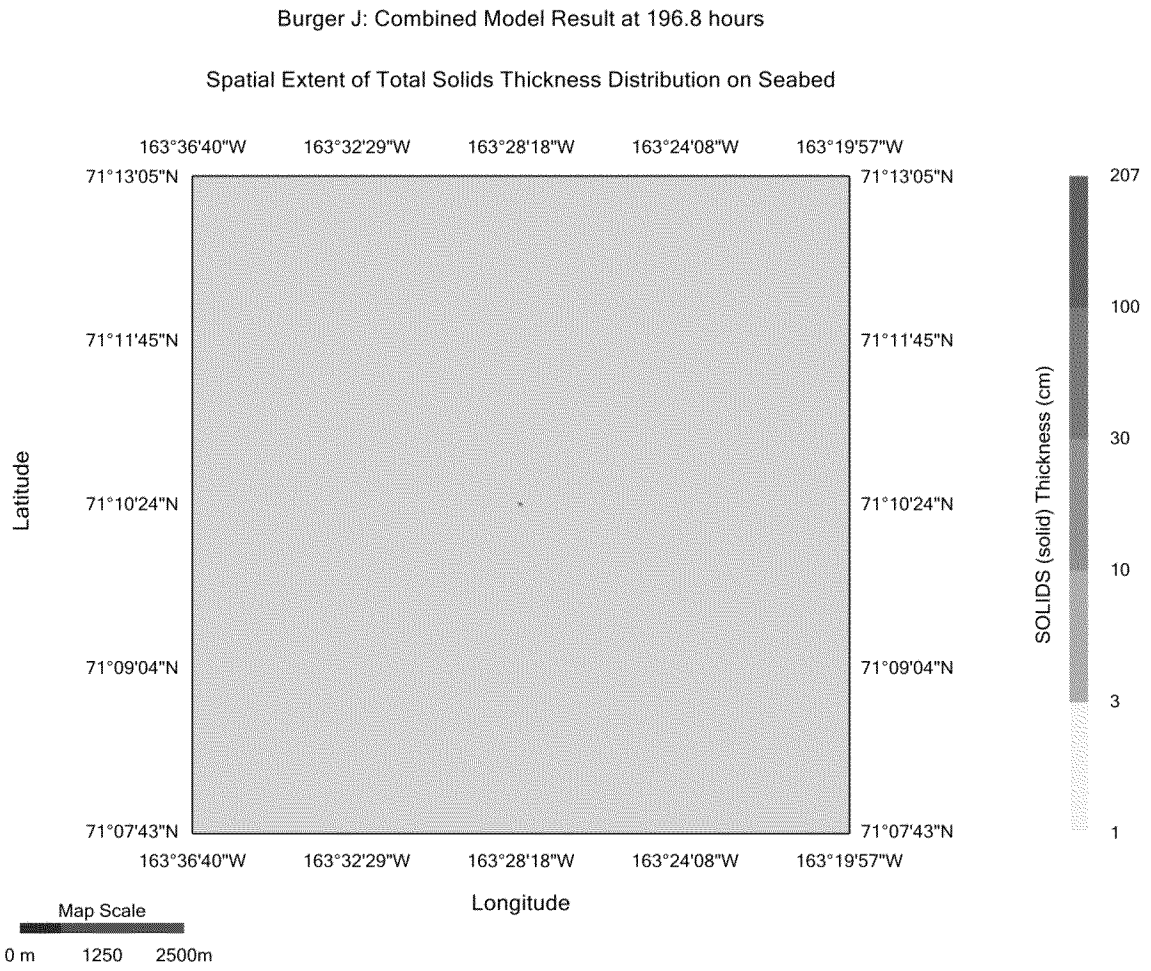


Figure 5-37b: Spatial extent of total solids thickness distribution on seabed, Burger J, Intervals 01-06 and Rig's Surface Pits

(Zoom In View)

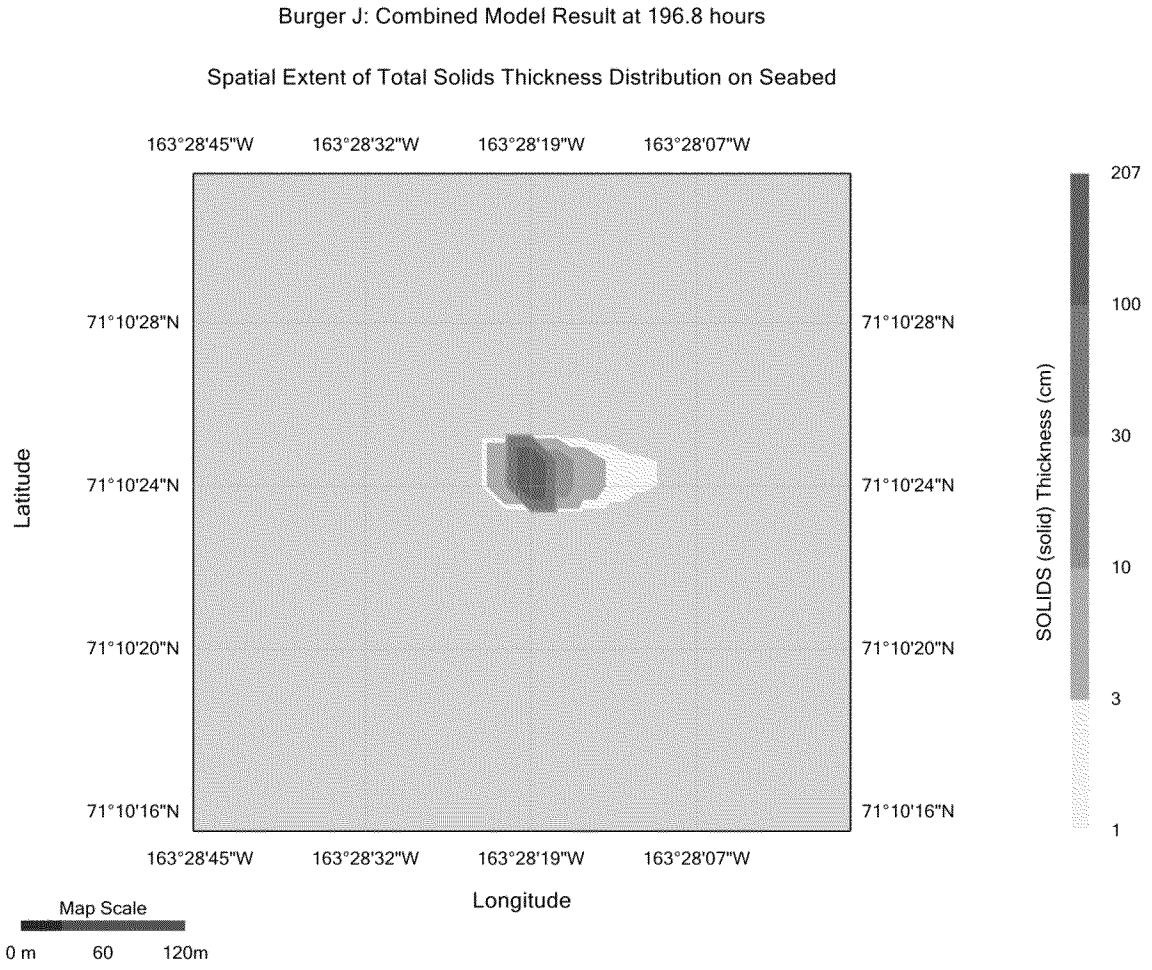
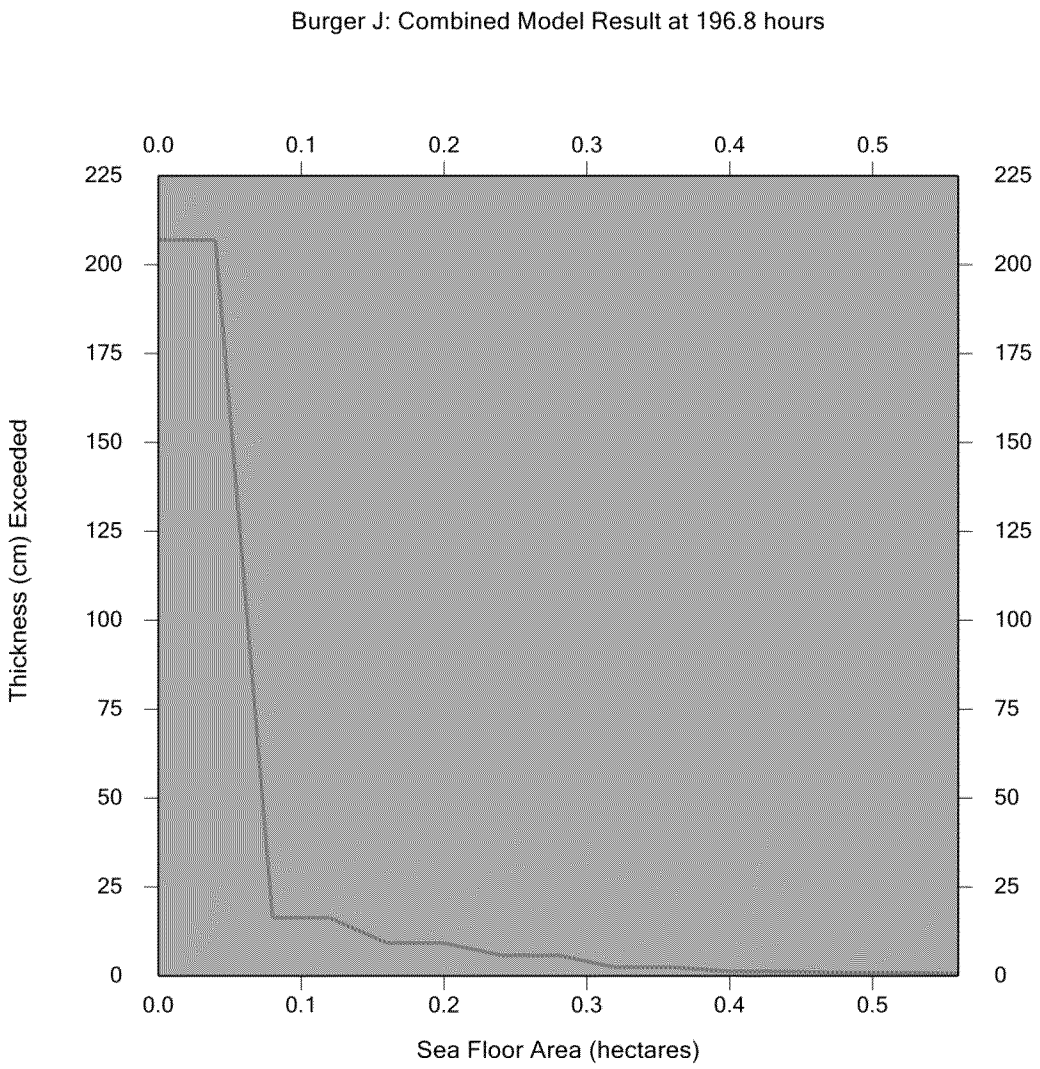


Figure 5-38: Sea floor area affected by solids thickness distribution, Burger J



The OOC model predictions for the solids deposition on the seabed from the cement, water based drill cuttings, and drilling fluids discharges from the six discrete drilling intervals and the rig's surface pits were compiled using the GUIDO 7 software yielding the total solids deposition loading and thickness distribution on the seabed from the drilling operations at the Burger J well site and are presented in **Table 5-2**. The total suspended solids (TSS) concentrations during the drilling operations are: 7 to 82 mg/l at 100 m; 2 to 19 mg/l at 300 m; and 0 to 3 mg/l at 1 km distances from the source. The maximum TSS concentrations occur during the discharge of drilling fluids from the Rig's surface pits for duration of 1.5 hours only. They are: 241 mg/l at 100 m, 104 mg/l at 300 m, and 0 mg/l at 1 km distances from the source.

Table 5-2: Summary Model Results - Sea Floor and Sea Surface Discharges, Burger J

The OOC Model Predictions												
Well ID	Discharge Scenario	Drilling Intervals	Duration of Discharge	Depth of Water	Depth of Discharge	Effluent Discharge Rate	Solids Deposition on the Seabed			Total Suspended Solids (TSS) Concentration in Water Column - (distances from the source)		
							Area Covered by Solids Thickness (ha)		Maximum Deposit Thickness	100 m	300 m	1 km
			Hours	m	m	bbls/hour	> 10 cm	> 1 cm	cm	mg/l	mg/l	mg/l
Burger J	Sea Floor	1	66.2	43.9	42.071	25,714.29	0.119	0.324	137.4	82.23	18.85	3.12
		2	5.2	43.9	42.071	25,714.29	-	0.117	8.7	66.63	15.29	2.46
		3	34.4	43.9	42.071	25,714.29	0.112	0.199	40.2	46.56	10.72	1.77
	Sea Surface	4	23.3	43.9	6.706	696.68	-	0.250	8.8	17.94	4.14	0.70
		5	29.0	43.9	6.706	700.54	0.098	0.269	14.0	21.82	5.02	0.87
		6	37.2	43.9	6.706	619.89	-	0.180	2.9	7.04	1.58	0.23
		Rig's Surface Pits	1.5	43.9	6.706	1,000.00	-	-	0.7	241.40	103.80	-
	At the end of Drilling						0.196	0.512	207.0	241.40	103.80	-

SECTION 6.0 SUMMARY AND CONCLUSION

The numeric modeling was performed to simulate the dispersion and deposition of the cement, water based drill cuttings, and drilling fluids discharges from the prospect well **Burger J** located offshore Chukchi Sea using the Offshore Operators Committee Mud and Produced Water Discharge Model (**OOC Model**). The prospect well Burger J is located in Block 6912 of area Posey. The depth of water is 43.9 meters (m). The dispersion and deposition numeric simulations were performed for the six discrete drilling intervals divided into two discharge scenarios: sea floor (013) and sea surface (001). The sea floor discharges occur from the drilling intervals 1, 2, and 3 and the sea surface discharges occur from the drilling intervals 4, 5, and 6. The sea floor discharges occur at 1.83 m (or 6 feet) above the sea floor and the sea surface discharges occur at 6.7 m below the sea surface.

A pump will be used at the sea floor during the drilling of the top hole section i.e., the drilling intervals 1, 2, and 3 for the sea floor (013) discharges. A flexible hose suction pipe will suck a large volume of sea water to move the cement, water based drill cuttings, and drilling fluids from the seafloor and will discharge from a 16.0 inch internal diameter discharge pipe at 18,000 gallons per minute (gpm). This yields into 118, 135, and 186 pre-dilution factors before discharging into the ambient for the drilling intervals 1, 2, and 3, respectively. The discharge pipe of the seafloor pump is located at 1.83 m (or 6.0 feet) above the seafloor and oriented horizontally aligned with the direction of the current, which is to the East. The sea floor pump's discharge rate of **18,000 gpm** is equivalent to **25,714.29 bbls/hour**.

Sea water at a rate of 10 bbls/min will be added to the drill cuttings and drilling fluids before discharging into the ambient during the drilling of the bottom hole section i.e., the drilling intervals 4, 5, and 6 for the sea surface (001) discharges.

The pre-diluted effluent discharge rates during the drilling intervals 1, 2, 3, 4, 5, and 6 are: 25714.29, 25714.29, 25714.29, 696.68, 700.54, and 619.89 bbls/hour, respectively. Cement is being discharged only for the sea floor discharge scenario and is included in the volume of drill cuttings. Approximately 1,500 bbls of drilling fluids will be discharged at the end of the drilling of the well from the rig's surface pits.

The solids deposition on the seabed from the effluents discharged during the six discrete drilling intervals and the rig's surface pits were compiled using the Graphical User Interface Discharge Offshore (GUIDO, version 7.0) software for the OOC model yielding the total solids deposition loading and total thickness distribution on the seabed from the drilling operation at the Burger J well site.

The OOC model predicted total amount of solids loading on the sea floor as a result of the discharge of cement, water based drill cuttings, and drilling fluids are: (i) less than 1 kg/m^2 at a distance 350 m from the source, (ii) less than 0.1 kg/m^2 at 1.1 km from the source, and (iii) less than 0.01 kg/m^2 beyond 2.7 km from the source.

The sea floor areas affected by solids deposit loading of more than 1000-, 100-, 10-, 1-, 0.1-, 0.01- and 0.001-kg/m^2 are: 0.108, 0.264, 0.594, 3.663, 18.610, 130.974, and 729.182 ha, respectively.

The OOC model predicted maximum deposit thickness of 207 cm occurs at 2.0 m north from the discharge location. It decreases to a value of 1 cm at a distance approximately 100 m to the east from the discharge location.

The sea floor area affected by solids deposit thickness of 1 cm or larger is approximately a 120 m x 40 m rectangle area (or 0.512 ha to be exact). The sea floor areas affected by deposit thickness larger than 200-, 100-, 10-, and 1-cm are: 0.081, 0.102, 0.196, and 0.512 ha, respectively.

The total suspended solids (TSS) concentrations during the drilling operations are: 7 to 82 mg/l at 100 m; 2 to 19 mg/l at 300 m; and 0 to 3 mg/l at 1 km distances from the source. The maximum TSS concentrations occur during the discharge of drilling fluids from the Rig's surface pits for duration of 1.5 hours only. They are: 241 mg/l at 100 m, 104 mg/l at 300 m, and 0 mg/l at 1 km distances from the source.

The impacts on the ambient from the drilling operations at the Burger J well in terms of solids deposit thickness of 1 cm or larger is limited to an area of less than 1 ha. The impacts at 100 m from the discharge source are: solids deposit thickness of 1 cm on the seabed and TSS concentrations in the range of 7 to 82 mg/l. The impacts beyond 300 m from the source are low: solids deposit thickness of less than 1 cm on the seabed and TSS concentrations of 2 to 19 mg/l. The overall impacts on the ambient from the drilling operations at the Burger J well can be classified as low.

SECTION 7.0 REFERENCES

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